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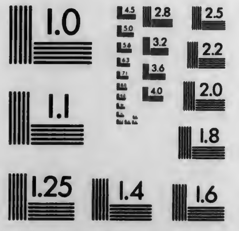

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APPENDIX S
FEDERAL POWER COMMISSION REVIEW OF POWER MARKET STUDY

Corps of Engineers, Department of the Army
North Pacific Division
October 1, 1948

REVIEW REPORT
ON
COLUMBIA RIVER AND TRIBUTARIES

APPENDIX S

REVIEW OF BONNEVILLE POWER ADMINISTRATION'S REPORT ON POWER MARKETS AND DEVELOPMENTS IN THE PACIFIC NORTHWEST

Prepared by
Federal Power Commission
San Francisco Regional Office

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PREFACE

1. The general problem of evaluating the present and prospective economic development of Columbia River Basin requires a review of the resources of the basin and of the markets for both the raw materials and for the manufactured products to be derived from those resources. Thus an analysis of need for development of hydroelectric resources, one of the most important Columbia Basin assets, requires a study of the markets for electrical power. Inasmuch as the Bonneville Power Administration is authorized by law to dispose of power generated at Bonneville and Grand Coulee Dams, the major existing Federal generating plants in Columbia River Basin, and because in conjunction with the discharge of its assigned responsibilities, that Administration had acquired the experienced personnel necessary for analyzing power markets, the Corps of Engineers requested that the Administration prepare a report on the existing and potential market for electric power in the basin and contiguous areas. That report, "Power Markets and Developments in the Pacific Northwest" has been reproduced as Appendix N.

2. As desired by the Corps of Engineers, the Bonneville Power Administration consulted with numerous Federal and State agencies during preparation of their report, taking the views of those agencies into account insofar as possible. In preparation for the Review Report, the Corps of Engineers also sponsored a series of semi-formal technical conferences dealing with and coordinating the several phases of the power study. These conferences were participated in by representatives of the Bonneville Power Administration, the Bureau of Reclamation, the Federal

Power Commission, and the Corps of Engineers, and such participation aided in coordinating preparation of drafts by the Administration. Drafts of the market studies were distributed by the Bonneville Power Administration to the appropriate agencies or contributors to the report for review and comment prior to assembly and submission of the final report to the Corps of Engineers.

3. The Bonneville Power Administration extimate of 1960 power requirements, which is the result of a thorough Northwest industrial survey, gives a rate of load growth equal to approximately 10 percent compounded annually. Inasmuch as the load growth from 1940 through 1947 was at the rate of 16 percent compounded annually, their estimate is not out of line with recent experience.

4. At the invitation of the Corps of Engineers, and under authority granted by the Federal Power Act, the Federal Power Commission has reviewed the study by Bonneville Power Administration and at the same time has made an independent survey of the power markets in the Columbia River Basin. Detailed comments of the Federal Power Commission on the Bonneville Power Administration power market study and the independent evaluation of the power market are contained in the report entitled, "Review of the Bonneville Power Administration Report on Power Markets and Developments in the Pacific Northwest", which has been reproduced herewith as Appendix S. The load estimates prepared by the two agencies differ considerably. According to the Federal Power Commission estimate of energy and peak power requirements, the load which the Bonneville Power Administration estimates for 1960 might not occur until 1970.

5. The primary reason for the difference between the two estimates is readily apparent. The Federal Power Commission estimate of future power market requirements has been made contingent upon the amount of new generation both Federal and non-Federal, which the Commission estimated would be available by 1960. On the other hand, the Bonneville Power Administration assumed load growth in accordance with demands of the region and not restricted by lack of adequate power supply. The magnitude of the load actually realized will, of course, be dependent upon the generating capacity available. The Bonneville Power Administration made no effort to evaluate this factor, considering it beyond the scope of a market report.

6. The main qualification imposed on the findings of the Bonneville Power Administration by the approach of the Federal Power Commission is recognized in the findings of the "Review Report on Columbia River and Tributaries", wherein a primary objective of the Main Control Plan, as recommended, is to provide sufficient Federal generating capacity to meet the peak load of about 10,000,000 kilowatts expected between 1960 and 1970 on the Federal system.

REVIEW OF THE
BONNEVILLE POWER ADMINISTRATION'S
REPORT
ON
POWER MARKETS AND DEVELOPMENTS
IN THE PACIFIC NORTHWEST

Federal Power Commission
Bureau of Power

San Francisco Regional Office
September 1948

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INTRODUCTION

This report presents the results of a review of the Bonneville Power Administration report entitled, "Power Markets and Developments in the Pacific Northwest." The B.P.A. prepared its report at the request of the Department of the Army, Corps of Engineers; the latter, in turn, requested the Federal Power Commission to review the Bonneville study.

The Bonneville report consists of 12 chapters as follows:

I - Introduction
II - Summary
III - Light Metals Industries
IV - Ferrous Metals and Related Industries
V - Nonferrous Metals Industries
VI - Nonmetallic Industries
VII - Electrochemical Industries
VIII - Forest and Forest Products Industries
IX - Agriculture and Food Processing
X - Railway Electrification
XI - Domestic Power Requirements - Urban and Rural
XII - Commercial, Small Industrial, Irrigation, Space Heating, and Miscellaneous Electric Requirements

The report is detailed and therefore voluminous, containing approximately 1,450 pages. In the review of this report it was believed necessary to (1) summarize the B.P.A. report to show the estimated requirements and the basis for the estimates; (2) prepare an independent estimate of future loads; and (3) compare the two estimates and discuss the reasons for any major differences.

This review report is therefore divided into the following parts:

Part I - Brief resume of B.P.A. report showing the 1960 load estimates and the principal assumptions upon which these estimates are based.

Part II - Load estimates made by F.P.C.

Part III - Comparison of B.P.A. and F.P.C. estimates, together with conclusions of the F.P.C. staff as to the reasonableness of the B.P.A. estimates.

In preparing the summary for Part I the greatest emphasis was given to those chapters that develop the estimates for the principal loads. The length or detail of the summary for any particular chapter is not therefore an indication of the space allotted to it in the B.P.A. report.

In making the load estimates shown in Part II advantage was taken of much of the statistical and factual data collected by B.P.A. The Administration's engineers and economists have cooperated with the F.P.C. staff in every way requested and have been most helpful in explaining the basis for their estimates.

SUMMARY

The geographical area considered by B.P.A. as a market for generation from hydroelectric plants in the Columbia River Basin includes all of the states of Washington, Oregon and Idaho, and 11 counties in western Montana. The market area considered in the F.P.C. load estimates includes these three states and nine counties in western Montana, omitting Silver Bow and Deer Lodge counties. These two counties include the mining and manufacturing activities of the Anaconda Copper Company located in the vicinity of Butte and Anaconda.

The inclusion of nine instead of eleven counties for the F.P.C. estimate in Montana was made in order to utilise data from a previous study. Therefore, exact comparisons cannot be made between F.P.C. and B.P.A. estimates for the entire region. However, exact comparisons are made for the state of Washington, Oregon and Idaho.

In making 1960 estimates of the region's power requirements, B.P.A. has analyzed the markets for power in (1) electro-process and other large industries; (2) forest and forest product industries; (3) agriculture and food processing industries; (4) railroad electrification; (5) homes and farms; and (6) commercial and small industrial establishments. In analyzing the 1960 power requirements a maximum and minimum estimate was made for the first three aforementioned groups. The minimums in general reflect estimates of expected requirements assuming the continuation of past trends and the completion of known plans. The maximums generally reflect potential power requirements assuming that policies of the federal government and industry will encourage the most rapid development of power resources in the area. In the case of home and farm, commercial, and "other" small industrial power requirements, a single figure is used.

In order to check the reasonableness of B.P.A.'s estimates, an independent study was made of the 1960 requirements. An analysis was made of (1) the past and future trends of population; (2) past and probable future use of farm, residential, and commercial customers; (3) the industrial energy consumption trends modified by the anticipated development of the region's natural resources and economic activities; and (4) other factors that might affect the power requirements of the region.

The comparison between the 1960 loads as estimated by F.P.C. and the B.P.A. adopted estimates as well as their minimum and maximum estimates for the Pacific Northwest Region and for the states of Washington, Oregon, and Idaho are shown in Part III of this report. For the states of Washington, Oregon, and Idaho, the B.P.A. minimum estimate of energy requirements exceeds the F.P.C. estimate by about 19 billion kilowatt-hours, and the B.P.A. adopted estimate exceeds the F.P.C. estimate by over 30 billion kilowatt-hours. The major differences are in the commercial and industrial classification, particularly in the aluminum industry.

These differences result in part from differences in approach and in part from differences of opinion concerning the interpretation and the probable effects of certain current trends. The B.P.A. analyzed potential markets without reference to the availability of generating capacity and without allowance for a business depression. It also assumes that federal power in the Northwest will maintain its relative cost with respect to alternative sources. The F.P.C. staff estimates have taken into account the practical effect of present and prospective limitations of power supply. F.P.C. also points out that costs of additions of major plants in the federal system do not differ greatly from costs of generating an equivalent amount of power in fuel-electric plants located near the natural gas fields on the Gulf Coast.

B.P.A.'s estimate for commercial use is about 88 percent higher than the F.P.C. estimate. This difference is due in part to the different interpretations placed on this classification. B.P.A. starts with a base of 2.01 billion kilowatt-hours in 1946 whereas F.P.C. uses 1.67 billion kilowatt-hours. The following tabulation shows for the states of Washington, Oregon, and Idaho, the difference between the two estimates:

	B.P.A. Estimate	F.P.C. Estimate	Difference Between B.P.A. and F.P.C. Estimate
Number of Customers	257,640	187,670	69,970
Use per Customer (Kwh)	27,488	20,068	7,420
Total Use (Million Kwh)	7,082	3,766	3,316

In the industrial classification the F.P.C. estimate is in general agreement with the minimum estimate made by B.P.A. with the exception of the aluminum industry.

In 1946 the Pacific Northwest produced 148,000 tons of primary aluminum, or 36.1 percent of the total production in the United States. During 1948 the region has been producing at a rate which is about 90 percent higher than the 1946 rate. This level of production is almost identical with the region's presently operable capacity and has been possible under a special short-term power contract. Looking to the future, B.P.A. estimates that the region's 1960 production could be from 323 to 486 percent greater than the 1948 production rate on the basis of their minimum and maximum estimate.

The next five to seven years will be critical ones for the aluminum industry, as it is believed that during this period the industry will have to expand very rapidly if it is to realize its feasible 1960 market. In view of the presently planned installation of hydroelectric generating plants, it seems probable that the growth of the Northwest's aluminum industry between now and 1955 will be retarded. It is likely

that during this period the greater part of whatever capacity is added to the industry's present total, will be located outside the Northwest. However, assuming that power will be available in the region after 1955, the greater part of the aluminum capacity to be built between then and 1960 may be located in the Pacific Northwest. In view of this, it is estimated that the region's aluminum industry will utilize somewhat less than 12 billion kilowatt-hours in 1960.

CONCLUSIONS

A. It is the opinion of the F.P.C. staff that the B.P.A. estimates of 1960 power requirements of domestic, small industrial, irrigation, street lighting, and miscellaneous are reasonable. Its minimum estimate for large industrial requirements excluding aluminum checks closely with estimates made by the F.P.C. staff.

B. Bonneville's commercial estimate is about 88 percent higher than F.P.C.'s. Its adopted estimate for total industrial requirements excluding aluminum for the states of Washington, Oregon, and Idaho is about 57 percent high in comparison with the F.P.C. estimates.

C. The B.P.A. estimates the national 1960 aluminum requirements between 1,696 and 2,679 thousand tons. Recently the aluminum industry has collectively estimated that the market for aluminum in the next decade would be from 1,500 thousand to 1,700 thousand tons. If allowance is made for roughly 200 thousand to 300 thousand tons of aluminum scrap, the requirements for primary aluminum would then be from 1,200 thousand to 1,400 thousand tons. It is the conclusion of the Federal Power Commission staff that the adoption of a figure of 1,200 thousand tons production of primary aluminum by 1960 would be reasonable.

D. Because of the foregoing, the total energy requirements estimated for the three states is almost 31 billion kilowatt-hours higher in the B.P.A. report than in the F.P.C. report. It should be noted however that B.P.A.'s estimates are for requirements without reference to power supply whereas F.P.C., in estimating power requirements for aluminum reduction, has given consideration to the possible effect of deficiencies in present and prospective power supply both from a regional and national standpoint.

E. Although the B. P. A. estimate of 1960 requirements considerably exceeds the F.P.C. estimate, it should be pointed out that the need for increasing the region's power supply is urgent. The present load of the region has overtaken the power supply, and the rate at which new generating capacity is being added is hardly sufficient to keep pace with load growth. Without any increase in the power supplied the aluminum industry above that now available, the region faces the danger of an acute power shortage during any year that adverse stream-flow conditions may prevail. Therefore, the rate of installation of new generating capacity should be accelerated in order to assure a sufficient power supply to serve the normal load growth in the Pacific Northwest.

PART I - SUMMARY OF B.P.A. REPORT

Chapter I - Introduction

Purpose

The Bonneville Power Administration's report gives the outlook for power markets and related developments in the Pacific Northwest by 1960. It was prepared for the Corps of Engineer, War Department, at its request, to be incorporated as part of their comprehensive review report on the Columbia River and tributaries.

Scope

The geographical area considered as a market for generation from hydroelectric plants in the Columbia River Basin includes all of the states of Washington, Oregon, and Idaho, and the portion of Montana west of the Continental Divide. Within this area the markets analyzed consist of (1) electro-process and other large industries; (2) forest and forest product industries; (3) agriculture and food processing industries; (4) railroad electrification; (5) home and farm; and (6) commercial and small industrial markets.

Methods

The basic method underlying the Bonneville report has been the analysis of factors and opportunities affecting the power consumption outlook in individual fields with the year 1960 selected as a point of future reference. A maximum and minimum estimate has been made for the first three of the aforementioned market groups, and are shown in the following tabulations:

Forest and Forest Product Industries

	Estimated Power Requirements in 1960 (1,000 Kwh)		(Kilowatts) 1/	
Consuming Operations	Minimum	Maximum	Minimum	Maximum
Total	2,377,667	3,697,811	691,733	1,016,796
Sawmills (rough lumber and mill work)	787,020	1,008,987	362,504	465,568
Plywood mills	115,600	184,285	37,697	60,112
Pulp mills	817,700	1,272,000	155,578	242,006
Paper mills	595,000	1,147,000	113,205	218,228
Other, including furniture, chemical and other secondary manufacture	62,347	85,539	22,749	30,882

1/ Non-coincident.

ESTIMATED RANGE OF ELECTRIC POWER CONSUMPTION AND DEMAND FOR SELECTED INDUSTRIES IN THE PACIFIC NORTHWEST IN 1960 COMPARED WITH 1939 AND 1945

Selected industry	Estimated consumption - megawatt-hours				Estimated demand - kilowatts			
	1939	1945	1960		1939	1945	1960	
			Minimum	Maximum			Minimum	Maximum
Total	1,445,800	5,812,650	29,092,300	42,460,500	235,200	977,000	3,641,450	5,384,100
Light metals	--	3,663,000	24,120,000	34,480,000	--	647,000	2,878,600	4,180,000
Aluminum	--	3,658,000	24,000,000	34,000,000	--	642,000	2,865,000	4,125,000
Magnesium	--	5,000	120,000	480,000	--	5,000	13,600	55,000
Ferrous metals	34,000	280,700	590,000	1,317,000	12,000	59,100	131,100	252,800
Rolled steel	20,000	65,000	120,000	220,000	8,000	25,000	42,000	71,000
Stainless steel	--	--	7,000	32,000	--	--	1,500	6,500
Iron and steel castings	14,000	55,000	95,000	130,000	4,000	14,000	40,000	55,000
Ferro-alloys	--	160,000	260,000	500,000	--	20,000	34,000	64,000
Electrolytic iron	--	--	45,000	300,000	--	--	6,000	40,000
Electrolytic manganese	--	700	63,000	135,000	--	100	7,600	16,300
Non-ferrous metals	1,184,500	1,470,350	1,647,000	2,134,000	181,500	205,500	250,000	327,000
Zinc	700,000	1,000,000	1,090,000	1,394,000	100,000	130,000	150,000	194,000
Lead	110,000	130,000	135,000	184,000	21,000	25,000	32,000	45,000
Copper	372,000	340,000	400,000	500,000	54,000	49,000	62,000	75,000
Antimony	2,500	350	22,000	56,000	6,500	1,500	6,000	13,000
Non-metallic	124,000	100,000	283,000	360,000	25,000	27,000	50,000	62,500
Cement	124,000	100,000	183,000	200,000	25,000	27,000	37,000	41,000
Artificial abrasives	--	--	100,000	160,000	--	--	13,000	21,500
Chemical	103,300	298,600	2,152,300	4,169,500	16,700	38,400	331,750	561,800
Phosphorus 1/	--	--	--	--	--	--	--	--
Phosphoric Acid	--	--	11,000	22,000	--	--	1,500	3,000
Phosphates	--	--	203,000	602,000	--	--	26,000	77,000
Phosphate fertilizer	2,000	4,000	1,243,000	2,039,000	500	1,000	167,400	275,800
Sulfuric acid	1,000	2,000	14,000	20,000	150	300	2,000	3,000
Calcium carbide	--	95,000	220,000	440,000	--	12,000	27,000	54,000
Acetylene	300	600	800	2,000	50	100	200	500
Acetic acid	--	--	3,500	10,500	--	--	450	1,500
Acetic anhydride 2/	--	--	--	--	--	--	--	--
Chlorine and caustic soda	100,000	165,000	325,000	465,000	16,000	21,000	46,000	66,000
Chlorates and perchlorates	--	32,000	32,000	48,000	--	4,000	4,000	6,000
Carbon disulfide	--	--	25,000	31,000	--	--	3,200	4,000
Rayon 3/	--	--	375,000	490,000	--	--	54,000	71,000

1/ Power requirements included in estimate for phosphoric acid, phosphates, and phosphate fertilizer.

2/ Power requirements included in estimate for rayon. 3/ The purchased power included in these figures is estimated as follows: megawatt-hours 75,000 and 110,000 and kilowatt demand 10,500 and 15,000.

Agriculture Food Processing Industry

Processing Industry	Estimated Power Consumption in 1960 (millions of kilowatt-hours)	
	Minimum	Maximum
Total	514	545
Milk processing	230	247
Meat dressing and curing	76	83
Flour milling	60	66
Sugar manufacture	60	53
Other agricultural products processing	88	96

In summarizing the power figures for the above industries, a single estimate has been taken by the Bonneville Power Administration between the minimums and the maximums. The minimums in general reflect estimates of expected requirements assuming the continuation of past trends and consummation of known plans. The maximums generally reflect potential power requirements assuming that policies of the federal government and industry will encourage the most rapid development of power resources and industry in the Pacific Northwest. In the case of domestic and other power requirements, a single figure is used.

Chapter II - Power Load in the Region

In appraising the future market for elctric power in the Pacific Northwest, the B.P.A. makes use of two significant characteristics of the power markets in this region which differentiate them from power markets of the rest of the country. First, the cost of power to ultimate consumers of the Pacific Northwest has for many years been lower than for any other large region of the United States. Second, the per capita use of electricity has been higher for this region than for the remainder of the United States. These two facts are indicated in the following tabulations:

Average Revenue per Kilowatt-hour (Cents)

Year	United States	Pacific Northwest
1940	2.06	1.35
1946	1.81	0.99

Per Capita Sales of Electricity (Kilowatt-hours)

1930	609	1,135
1940	899	1,550
1946	1,512	3,512

The growth of sales of energy to ultimate consumers increased from 4,620 million kilowatt-hours in 1937 to 14,626 million kilowatt-hours in 1944, when sales reached their peak. Nineteen forty-six sales decreased to 12,551 million kilowatt-hours, mainly due to the closing down of four of the six aluminum plants in the region, upon termination of hostilities.

In estimating the probable power requirements of the région for 1960, B.P.A. estimates were made on the basis that adequate power supply would be available for all potential requirements. In the Bonneville report it has been assumed that it would be possible to construct additional generating capacity during the intervening period at a sufficiently rapid rate to meet the requirements of the region. (It is stated however, that for a considerable number of years the electric requirements will be limited by the available power supply.) It has also been assumed that the region will not experience a serious economic depression during this period. It is brought out that a depression would not alter the magnitude of the estimated loads but would change the timing. Similarly, no cognizance of the possibility of the United States becoming a participant in another war has been taken into consideration.

Following is shown a tabulation indicating the Bonneville estimates of growth in power requirements for the entire region, by 1960, as compared with the requirements in 1946.

Estimate of Electric Power Requirements

	1946		1960	
Class of Customer	Total Requirements (Million Kwh)	Contribution to December Peak (1000 Kw)	Total Requirements (Million Kwh)	Contribution to December Peak (1000 Kw)
Urban Domestic	2,273		5,003	
Rural Nonfarm	464		2,131	
Farm	376		1,920	
Subtotal	3,113		9,054	
Commercial	2,007		7,200	
Small Industrial				
Food Processing	295		530	
Other	1,189		3,469	
Subtotal	1,484		3,999	
Subtotal	6,604	1,389	20,253	4,533
Large Industrial				
Forest Products	2,100	319	3,038	454
Aluminum I 1/	2,838	580	6,563	807
Aluminum II 2/	-	-	22,737	2,693
Other 3/	2,152	397	10,514	1,568
Subtotal	7,090	1,296	42,852	5,522
Space Heating	80	50	667	370
Irrigation	351	-	2,286	-
Street Lighting	86	25	226	65
Miscellaneous	412	59	800	114
Total	14,623	2,819	67,084	10,604
Total (Including Transmission and Distribution Losses)	16,378	3,157	76,476	11,840

1/ Requirements of existing aluminum pig metal plants plus existing and potential loads of alumina plants and aluminum fabricating plants. 2/ Potential increases in load of aluminum pig metal plants in excess of requirements of existing plants. 3/ Includes requirements of electrified railroads.

In addition to the data shown on the preceding tabulation this chapter presents tables showing the actual power requirements, by use classifications, for 1946 and 1947, and estimated requirments for each year through 1960. These data are presented by load areas. The following tabulation shows the actual 1946 use (as shown in the Bonneville report) by Areas, together with that estimated for 1960. This includes generation by industries for own use.

	Energy Requirements - Million Kwh	
	1946	1960
Western Washington	8,032	38,890
Eastern Washington	2,538	11,172
Western Oregon	3,148	17,233
Eastern Oregon	421	1,382
Northern Idaho	615	1,278
Southern Idaho	735	4,673
Western Montana	889	1,848
Total Pacific Northwest	16,378	76,476

It is pointed out in the report that hydroelectric energy is the base for industrialization in the region and that because of the rapidly diminishing supply of waste wood, the high costs of Utah coal and California oil, and the absence of natural gas, an ever increasing proportion of the region's energy requirements must be supplied from hydroelectric sources.

Chapter III - Light Metals Industries

Expansion of the aluminum industry since 1939 has been responsible for much of the growth of power requirements in the Pacific Northwest. Aluminum reduction capacity in the region is now 632,000,000 pounds per year, or 46 percent of 1947 national capacity. Of five reduction plants and one rolling mill operating during the war, three reduction plants and the mill were in operation in June 1947, while the other two plants are scheduled to reopen in 1947 and 1948. The one magnesium plant that operated during the war is now closed, but held in stand-by for national defense.

Aluminum is enjoying the largest relative postwar expansion of any of the principal metals. The production increase from 1939 to April 1947 has been four-fold.

The peacetime year of largest domestic production of primary aluminum was 1939 when nearly 164,000 short tons were produced in the Nation. The war program expanded the national production to a peak of 920,000 tons in 1943. Cancellation of war orders caused a sharp cutback to 410,000 tons in 1946, but rapid expansion of markets and reopening of government plants increased production to the rate of 565,000 tons annually by April 1947, 42 percent of which was contributed by the Northwest.

B.P.A. estimates that power requirements of the aluminum industry in the Pacific Northwest by 1960 will be between 2.8 and 4.1 million kilowatts as compared with a peak wartime demand of 686,00 kilowats. This large increase is based on the following facts and assumptions:

Facts About the Aluminum Industry

1. Eight to ten kilowatt-hours used per pound of metal produced.
2. Soderberg plants (electrodes continuously replenished) may consist of 120 cells having annual capacity of 20 million pounds. Each cell takes 32,000 amperes and produces 500 pounds in twenty-four hours.
3. Plants using prebaked electrodes consist of 128 cells having annual capacity of 32 to 36 million pounds. Each cell takes 52,000 amperes and produces 800 pounds in twenty-four hours.
4. In the Pacific Northwest there are two Soderberg plants with annual capacity of 102 million pounds and three prebaked electrode plants with annual capacity of 530 million pounds. Total Pacific Northwest capacity is 632 million pounds.
5. Each short ton of aluminum requires approximately the following raw materials:

Alumina	- 3800 - 4000 lbs
Carbon electrodes	- 1200 - 1600 lbs

Cryolite - 50 lbs
Aluminum fluoride - 70 lbs

6. Present capacity of aluminum industry in Pacific Northwest requires 5,700 million kilowatt-hours, or 670,000 kilowatts at 98 percent load factor. Rolling mill would require an additional 50,000 kilowatts.
7. The four alumina plants in this country are located near or in the South in order to be near bauxite deposits of Arkansas or imports from South America.
8. Freight costs from alumina plants to the Northwest is (April 1947) $8.36 per short ton.
9. Northwest could supply an alumina plant with ore and lime, but not soda ash. This would have to come from Green River, Wyoming, a distance of 970 rail miles. Lime would have to be obtained from islands 800 miles by boat north of Seattle.
10. Costs of producing pig aluminum at various points in the Nation vary from 7.555 to 10.531 cents per pound.
11. In addition to production costs the Pacific Northwest plants would have to pay up to 0.3 cents more per pound than the costs from competing plants for delivery of metal to Eastern markets.
12. Alumina costs amount to between 32 and 41 percent of total cost. Power costs range between 17 and 26 percent of total cost.
13. Primary aluminum production in the United States for a number of years is shown below:

	Average Annual (Short Tons) Production	Index 1910-14 = 100	Average Annual Cumulative Rate of Increase
1910 - 14	22,085	100	
1915 - 19	58,867	266.5	33
1920 - 24	54,543	247.0	15
1925 - 29	88,962	402.8	20
1930 - 34	67,077	303.7	10
1935 - 39	125,087	566.4	19
1940 - 44	546,616	2,475.0	79
1945 - 46	453,059	2,051.4	61

14. The major influences which will tend to accelerate the growth of the aluminum industry are (1) the lowest prices in history associated with increases in the prices of competing metals; (2) widespread knowledge of handling aluminum gained by some two million workers during World War II; and (3) the existence of domestic competition for the first time.
15. Estimated national market for aluminum in 1960 is shown in the following tabulation:

United States Outlook for Feasible Markets for Aluminum, 1960

Feasible Markets	Estimated Aluminum Requirement (Million Pounds) Minimum	Maximum
Building products	350	700
Automobiles	285	1,380
Displacement of copper 1/	250	450
Wire and cable	175	300
Other uses	75	150
Trucks	211	968
Light	3	9
Medium	175	810
Heavy	18	81
Trailers	15	68
Buses	40	56
Railroad cars	51	88
Aircraft	51	109
Displacement of zinc die castings 1/	34	52
All other uses	2,500	2,500
Total	3,772 1/	6,303 1/

1/ There is some duplication of figures representing displacement of copper and zinc because of the use of these metals in automobiles, trucks, and buses for which aluminum estimates were made without an analysis of metals displaced.

The assumptions upon which these national market estimates were based are as follows:

A. Building Products

(1) Building requirements in 1946 amounted to 350 million pounds. By 1960 the minimum amount will be 350 million and the maximum will be 700 million.

The maximum housing requirements were estimated as follows: Prefrabricated houses may use about 4,000 pounds per unit. Assuming 1,000,000 residential units per year; 20 percent prefrabricated; 50 percent of prefabs using aluminum and all prefabs using 600 pounds of aluminum roofing, the requirements would be 520 million pounds. Another 100 million may be used for window frames.

B. Automobiles

(1) Passenger car production in 1960 will be 3 million cars.

(2) Ninety percent will be in Ford-Chevrolet-Plymouth price range.
(3) Low-price class will use 100 to 500 pounds per car. High-price class will use small amounts of aluminum, about 50 to 100 pounds per car.

C. Displacement of Copper

(1) Favorable price relationship will continue for period 1947 - 60.
(2) Consumption of copper wire and cable in absence of aluminum would run between 350,000 and 400,000 tons per year.
(3) Aluminum will replace one-half to three-fourths of the copper on basis of one pound of aluminum for two pounds of copper.
(4) Aluminum will replace one-fourth to one-half of a miscellaneous copper market amounting to about 450,000 tons per year.

D. Trucks and Truck Trailers

(1) 1960 production; 315,000 lightweight, 350,000 medium weight, 35,000 heavy trucks, and 30,000 trailers.
(2) Ten percent of light trucks will use 100 to 300 pounds of aluminum each; one-half to three-fourths of medium and heavy trucks and trailers will use 1,000 to 3,000 pounds each.

E. Buses

(1) 1960 production; 8,000 buses excluding school buses. (Average 1936 to 1940, 7,300)
(2) 5,000 to 7,000 pounds of aluminum will be used per bus.

F. Railway Cars

(1) 1960 production; 16,000 box cars, 19,000 gondola and hopper, 1,000 tank, 1,000 refrigerator, and 1,000 passenger cars. The total aluminum capacity was determined as follows:

Cars to be Built

Type Car	Total	Using Aluminum	Use of Aluminum per Car - Lbs.	Total Million Pounds
Box	16,000	2,000 - 3,000	8,000	16 - 24
Gondola	19,000	2,000 - 4,000	10,000	20 - 40
Tank	1,000	200 - 500	7,000	1.4 - 3.5
Refrigerator	1,000	300 - 500	12,000	3.6 - 6.0
Passenger	1,000	500 - 700	20,000	10.0 - 14.0
				51.0 - 87.5

G. Aircraft

(1) Army will building 3,000 to 5,800 planes per year and Navy 1,000 to 2,000. Aluminum required for such a program estimated at 26 to 64 million pounds.
(2) Aluminum requirements for civilian planes estimated at 25 to 45 million pounds.

H. Displacement of Zinc Die Castings

(1) High-grade zinc will continue to sell above ten cents per pound.
(2) In view of permanent price advantage foundaries may be expected to switch steadily from zinc to aluminum.
(3) 250 to 300 million pounds of zinc castings would be required annually by 1960 in the absence of aluminum. Aluminum could displace 88 to 135 million pounds resulting in aluminum requirements of 34 to 52 million pounds.

I. All Other Uses

B.P.A. estimates a national market of 2,500 million pounds in this classification. (This is 66 percent of total minimum estimate and 40 percent of total maximum estimate.)

Principal Assumptions on Which Estimates for Pacific Northwest Aluminum Production are Based

1. Because power costs are more variable, they have been the principal factors in plant locations. Plants have been placed where abundant and low-cost power was obtainable.
2. The more economical Eastern production capacity is prevented from expansion by lack of additional sources of low-cost power.
3. It is most likely that further expansion of the industry will take place mainly in the Pacific Northwest provided the Federal Government continues its policy of expanding the power supply, building transmission lines and substations, and selling firm power at or near the present rate of $17.50 per kilowatt year.
4. Until 1955 the availability of low-cost power in the Pacific Northwest will continue to be a strong factor in the expansion plans of the industry. After 1955 these plans may be influenced by the costs of atomic power.
5. Political and economic considerations make it unlikely that Canadian aluminum will substantially displace Northwest aluminum in competing for domestic markets.
6. Primary metal requirements will be supplied from domestic production -- imports will be negligible or will be substantially offset by exports.

Factors Unfavorable to Development of Aluminum Industry in Pacific Northwest

1. By 1960 the use of atomic power may favor expansion of reduction and alumina capacity of Gulf area, closer to bauxite and aluminum markets.
2. Production of alumina from Northwest ores would begin only after the costs of delivering imported bauxite have become less economical or national policy should encourage production by subsidies.
3. Low-cost gas in the Gulf area permits the generation of low-cost power. There are disadvantages, however, to dependence upon gas for aluminum production.
4. The increased demands from the aluminum industry of power in the Northwest would come about 1954 when new power supplies will begin to become available from dams now authorized or under construction. It would be impossible for the Northwest to supply all the power needed for aluminum and at the annual rate required, unless additional dams are authorized in the near future. And, unless this were done, the aluminum industry could not plan sufficiently in advance all of the expansion that is possible for the Northwest.

Magnesium is now the cheapest material for airplane wheels, seats, supercharger housings, window frames, and trim on airplanes, for warp beams in the textile industries, and for many other industrial uses where its properties in various alloys can save money. The largest single market at present is for alloying with aluminum. These requirements amounted to ten million pounds in 1946.

At present, magnesium is used in the Northwest in aircraft manufacture and for alloying with aluminum. There is neither magnesium metal production nor fabrication in this region. A plant at Spokane, Washington, with a capacity of 48 million pounds of magnesium per year is now idle and held in stand-by as a part of the national defense program. After B.P.A. report was prepared this plant was acquired for electrochemical production. Its minimum power requirements operating at 50 percent capacity would be approximately 240 million kilowatt hours per year and a demand of 28,000 kilowatts.

Magnesium is the lightest of all structural metals and the sixth most abundant element on earth. The greatest obstacle to large scale production and use is cost of fabrication. Alloyed magnesium ingot, costing about 23 cents per pound, reaches a selling price of about 80 cents per pound when rolled into sheets and approximately 75 cents a pound as die castings.

Magnesium is produced by two basic processes:

(1) The electrolysis of magnesium chloride.
(2) The thermal reduction of magnesium oxide which produces magnesium powder.

The power requirements of the electrolytic process used by The Dow Chemical Company amounts to 9.5 kilowatt hours per pound of magnesium, while the process used in the Pacific Northwest requires 10 kilowatt hours per pound of magnesium.

Operation of a magnesium metal plant in the Pacific Northwest depends upon the following:

(a) Conversion of the Spokane plant so as to produce metal at not more than 3 cents above the cost of production on the Gulf Coast.
(b) The invention and perfection of a new and cheaper method than the sea-water electrolytic process, provided such a process has special adaptability to raw materials available in the Pacific Northwest.
(c) A peacetime annual demand for magnesium amounting to approximately 300 million pounds. (1946 market required about 25 million pounds.)

There were in the Nation thirteen government-owned and three privately owned magnesium plants at the end of the war with a capacity of 586 million pounds. Of these, only one plant was in operation in October 1946, having a capacity of 18 million pounds (half of Freeport, Texas, plant).

Total national markets for both primary and secondary magnesium are about 37 million pounds per year at the present time. There are 100 million pounds of scrap magnesium recoverable from military aircraft and 50 million pounds from incendiary bomb clusters. This scrap can be expected to come into the market at low prices (3 to 7 cents per pound) and to curtail the demand for primary ingot during a period of several years.

The B.P.A. estimates that by 1960 the power requirements of the Pacific Northwest for the magnesium industry will be between 120 and 480 million kilowatt hours with corresponding peak requirements between 13,600 and 55,000 kilowatts. This estimate is based on the following assumptions:

1. Potential consumption of magnesium in the Pacific Northwest at present time for alloying with aluminum is 8 million pounds per year.
2. Assuming an increase in the aluminum output to between 2.6 and 3.6 billion pounds by 1960, the magnesium required for alloying would increase to between 39 and 54 million pounds.
3. The Nation may require 300 million pounds of magnesium per year by 1960. In terms of ultimate consumption in proportion to population, the Pacific Northwest should have a basis for a market by 1960 of 4 percent of the national total, or 12 million pounds annually.
4. Assuming that 12 million pounds is required in the Pacific Northwest and that an electrolytic sea-water magnesium plant is

installed to produce it, the plant would require 120 million kilowatt hours and 13,600 kilowatts.

5. The Spokane ferrosilicon plant which is held in reserve for national defense would in the event of war require 480 million kilowatt hours per year at a demand of 55,000 kilowatts.

Chapter IV - Ferrous Metals - Related Industries

Known iron deposits in Pacific Northwest are small, and iron content averages below 50 percent. Coal deposits are not of the coking grade. The development of steel plants, therefore, would be dependent upon the development of variations in the standard blast furnace process in order to utilize local coal and hydroelectric power.

The rolled steel industry is established with two plants in Seattle and one in Portland. Two of these plants use electric furnaces. Steel ingot capacity in the Pacific Northwest in 1945 was about 406,800 net tons, or only 0.4 percent of the national. About one-half of this capacity was electric furnace.

Electric power required for steel ingot production by electric furnaces ranges from 500 to 700 kilowatt hours per net ton. Where a combination process is used and the charge is melted in a cupola furnace, power requirements are reduced to between 100 and 200 kilowatt hours per net ton.

Market for rolled steel in the Pacific Northwest in 1939 was 550,000 net tons while exports to markets accessible to the West Coast amounted to 1,000,000 tons.

B.P.A. estimates that the consumption of rolled steel in the Pacific Northwest in 1960 will be between 800,000 and 1,000,000 tons. They estimate that the production of steel ingots and rolled steel will be between 915,000 and 1,100,000 net tons. Power required is estimated at 120 to 220 million kilowatt hours, with a demand 42,000 to 71,000 kilowatts.

The stainless steel industry could be developed in the Pacific Northwest since the region contains all the required raw materials plus a source of low-cost power.

Stainless steel is an alloy containing 12 to 18 percent chronium or higher and a very low carbon content. It is usually produced by the electric furnace process and requires about 600 kilowatt hours per ton.

B.P.A. estimates that by 1960 from 6,000 to 20,000 tons will be produced annually in the region. Electric furnace power requirements plus the power requirements of producing ingots and other related operations are estimated at 7 million to 32 million kilowatt hours, with a related demand of 1,500 to 6,500 kilowatts.

Iron and steel castings were, in 1946, produced in 23 foundries in the Pacific Northwest having a total capacity of approximately 100,000 tons, or 3-1/2 percent of the national capacity. In 1945 these foundries produced 63,000 tons and consumed about 20 million kilowatt hours.

B.P.A. estimates that by 1960, the Pacific Northwest will have markets available requiring annual production of 40,000 to 50,000 tons of steel casting and 90,000 to 110,000 tons of gray iron castings. Power requirements are estimated at 95 to 130 million kilowatt hours and 40 to 55 thousand kilowatts demand.

Ferro-alloys production is used, almost entirely, by the steel-making industry. Ferromanganese and ferrosilicon are most widely used.

All ferro-alloys used in the West have been supplied by Eastern producers. The electric furnaces used by the three Western producers at the close of World War II had an aggregate capacity of only 26,000 kilowatts, or 3-1/2 percent of total national capacity.

A large existing freight differential is a considerable disadvantage for Western producers. B.P.A. estimates a 1960 production of 75,000 to 95,000 tons of ferro-alloys, requiring 260 to 500 million kilowatt hours and 34,000 to 64,000 kilowatts.

Electrolytic iron is the cheapest source of sintered iron powder used in industry. Present costs of production range from a few cents to more than $1.00 per pound, depending on the type of powder produced.

B.P.A. believes that if sufficient volume is attained, cost of production will be reduced below 10 cents per pound. A minimum production of 15 tons per day in 1960 will require 45 million kilowatt hours per year and 6,000 kilowatts. However, if costs are lowered to 5 per pound, B.P.A. estimates a power requirement of 300 million kilowatt hours and 40,000 kilowatts to produce 100 tons of electrolytic iron per day.

The United States production of electrolytic manganese at the end of 1946 was concentrated in only one plant of the Electro Manganese Corporation at Knoxville, Tenessee. Production of this plant in 1946 was 7.5 tons per day.

Possible uses for electrolytic manganese are still in the experimental stages. B.P.A. estimates the production of electrolytic manganese in 1960 as 50,000 tons, of which from 7,000 to 15,000 tons could be supplied from plants in the Pacific Northwest. This estimate would require from 63 to 135 million kilowatt hours and from 7,600 to 16,300 kilowatts.

Chapter V - Nonferrous Metals Industry

The most important minerals produced in Idaho and Montana are nonferrous metals. Large quantities of power are consumed in the mining and electrolytic separation of these minerals.

In 1944 nearly one-fourth of the domestic production of zinc and lead, one-eighth of the gold and copper, one-half of the silver, and practically all of the antimony came from the Pacific Northwest.

In view of the decreasing zinc production in the Tri-State and Eastern mines; the large reserves of zinc-lead ores in the Pacific Northwest, Alaska, and British Columbia; and the availability of low-cost power, B.P.A. estimates that new electrolytic zinc plants will be erected in the Puget Sound and Lower Columbia areas by 1960. The estimated power consumption for 1960 for zinc mining, concentrating and slab production is from 1,090 to 1,394 million kilowatt hours and from 150,000 to 194,000 kilowatts.

The present world shortage of lead will probably continue indefinitely, because of steady depletion of Missouri and Tri-State deposits unless the large lead reserves existing in the Pacific Northwest are called upon to make up the deficiency.

In 1944, of 11 smelters in the United States, 7 were in the Western States and of 8 refineries in the United States, 3 were in the West.

Based on a production of from 160,000 to 200,000 tons of ore and concentrates and 130,000 to 180,000 tons of pig lead, the estimated power requirements in 1960 are 135 to 184 million kilowatt hours and 32,000 to 45,000 kilowatts.

The largest known reserves of copper in the Pacific Northwest are in the property of Anaconda Copper Mining Company at Butte, Montana. Two smelters in the Pacific Northwest represented, in 1944, 16 percent of United States smelter capacity. Two refineries, at Tacoma, Washington, and Great Falls, Montana, represented about 19 percent of United States electrolytic refinery capacity.

Total production of refined copper in the Pacific Northwest in 1960 is estimated as 125,000 to 175,000 tons. Power required for this production is estimated between 400 to 500 million kilowatt hours and 62,000 to 75,000 kilowatts.

The Yellow Pine mine at Stibnite, Valley County, Idaho, is the largest domestic producer of antimony in the United States. Domestic consumption in 1960 is estimated at 50,000 tons. Assuming a tariff-protected price of 15 cents per pound to offset Chinese antimony imports, and other favorable circumstances, a production of 3,000 to 5,000 tons in the Idaho refineries is expected by 1960. This production would require 22 to 56 million kilowatt hours and 6,000 to 13,000 kilowatts.

Chapter VI - Nonmetallic Industries

Only two industries are discussed in this chapter -- the cement, and the artifical abrasives industries.

The cement industry is particularly important in the Pacific Northwest because of the high rate of construction in this area. Although the cement industry is not truly an electro-industry, it is a large power consumer which used nearly 4 percent of all industrial power consumed in 1939. Energy requirements range from 22 to 23 kilowatt hours per barrel of cement produced.

The cement plants of California offer the greatest competition to Pacific Northwest plants although their costs are somewhat higher.

At present (1947) a program is being developed by the aluminum Company of America to bring limestone from southeastern Alaska to Puget Sound and Columbia River points. This projected shipment is expected to eliminate much competition from California cement, and assuming a rather high level of construction in the next two decades, it is estimated that the 1960 cement production will range from 8.0 to 9.0 million barrels. The 1946 production was 4.7 million barrels.

The power requirements corresponding to these production figures would be 183 to 200 million kilowatt hours and 37,000 to 41,000 kilowatts.

The manufacture of artificial abrasives requires large quantities of electric energy in electric furnace. The two most important artificial abrasives produced in the United States are silicon carbide and fused alumina. The acquisition of a plant site in Vancouver, Washington, by the Carborundum Company in 1947 constitutes the initial step in the establishment of this industry in the Pacific Northwest. B.P.A. estimates that other plants of this type may be established in this area by 1960, having a total production of 8,000 to 12,000 tons of silicon carbide and 10,000 to 20,000 tons of fused alumina. Power requirements for this production would be 100 to 160 million kilowatt hours and 13,000 to 21,500 kilowatts.

Chapter VII - Electrochemical and Related Industries

The electrochemical and related industries, for the purpose of this report, have been divided into 7 groups: (a) phosphorous and phosphate products; (b) sulphuric acid; (c) calcium carbide and derivatives; (d) chlorine and caustic soda; (3) chlorates and perchlorates; (f) carbon disulfide; and (g) rayon.

(a) The discussion of phosphorous and phosphate products is presented in four sections: (1) mining of phosphate rock and electric furnace production of elemental phosphorous; (2) phosphoric acid produced from elemental phosphorous; (3) phosphates made from phosphoric acid; and (4) the phosphate fertilizer industry.

The Pacific Northwest has tremendously large reserves of phosphate rock located in southern Idaho, western Montana, Wyoming, and northern Utah. These deposits represent one of the three major deposits in the United States--the other two being Tennessee and Florida.

There are at present only two phosphate fertilizer plants in this region, one is in Anaconda, Montana, and the other in Pocatello, Idaho. Of the several alternatives for supplying the markets with Western phosphate fertilizer, the manufacture of elemental phosphorous (near the phosphate rock mines) through the use of electric furnaces and shipment of phosphorous to factories located near the point of use, appears to provide the ultimate in economical operation for long-distance moving of products and consequently has potentials in the Pacific Northwest, where potential low-cost hydroelectric power is abundant.

(b) Sulphuric acid is the most widely used acid in the chemical industry and the production of sulphate and superphosphate fertilizers constitutes the largest single market for sulphuric acid in the Northwest. In 1946, 49 percent of all the sulphuric acid plants in the United States were operated jointly with superphosphate plants.

(c) The manufacture of calcium carbide is an important electro-industry which was started in the Pacific Northwest in 1941 when two new plants were built in Portland. These are the only two plants west of the Mississippi River except one at Keokuk, Iowa.

Practically all calcium carbide is converted into acetylene which has two general uses in welding and cutting of metal and in the manufacture of synthetic chemicals.

The annual capacity of the two carbide plants in Portland in 1946 was approximately 27,000 tons. B.P.A. estimates a minimum production in 1960 in the Pacific Northwest of 70,000 tons to be converted to acetylene, of which 34,000 tons would be used to supply the local region, 32,000 tons may be shipped to other Western States, and 4,000 tons sold in foreign markets.

(d) The chlorine-caustic soda industry was one of the first electro-industries to be established at Pacific Northwest tidewater locations. The bulk of the chlorine production in 1946 was utilized by the chemical industry in the treatment of coal tar-, petroleum-, and natural gas-hydrocarbons, acetylene, and other raw materials. The pulp and paper industry consumes about 20 percent of all production. Caustic soda is used in the manufacture of soap, petroleum products, rayon, etc.

B.P.A. expects that there will be capacity within the Pacific Northwest in 1960, at least, equal to the volume of accessible market for chlorine, or 85,000 to 122,000 tons. The quantities of caustic soda that would be produced in conjunction with these quantities of chlorine would not be sufficient to meet the potential market. It is likely that one lime caustic soda plant would be installed to meet the excess demands.

(e) Sodium and potassium chlorates have been manufactured in Portland since 1941. Electrolytic cells are used to make the chlorates. Perchlorates have not been made in the Pacific Northwest. Sodium perchlorate is derived by further electrolysis of sodium chlorate. Ammonium and potassium perchlorates and perchloric acid are made from sodium perchlorate.

In 1945, the Pennsylvania Salt Manufacturing Company in Portland, Oregon, consumed 31 million kilowatt hours and used 3,900 kilowatts. No new plants are expected to be established in this region by 1960; production, however, is expected to continue to increase with normal developments in this industry.

(f) Carbon disulfide is primarily used in making viscose rayon and cellophane. There was no market for carbon disulfide in rayon manufacture in the Western States in 1946 and the only existing plant using carbon disulfide is located at Richmond, California, probably used its production for such minor uses as fumigation, pest control, solvents, etc. The manufacture of carbon disulfide in the Pacific Northwest depends entirely on the future manufacture of viscose rayon and/or cellophane in the region.

(g) The Pacific Northwest entered the rayon picture in 1929 when it was discovered that dissolving grades of bleached sulphite pulp from Western hemlock were among the superior pulps for rayon manufacture. Introduction of sustained forest yield practices virtually guarantees a permanent annual output of such pulps. Practically all the other raw materials and chemicals needed in the manufacture of rayon are available in the Northwest at reasonable cost. There is plenty of water and power is cheap. Such considerations indicate that rayon plants could be established in this region.

B.P.A. estimates that plants would be established at Eugene, Oregon; Longview, Washington; Puget Sound area, Washington; and Willamette Valley, Oregon; aggregating a production of 135 to 175 million pounds of rayon per year by 1960.

The power requirements to meet the foregoing production are shown in the following tabulation:

Estimated Production and Power Requirements
(1960)

	Annual Production (Tons)		Annual Energy Required (1,000 Kwh)		Annual Demand (Kw)	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
(a) Phosphorous & Phosphate Products	1,334,000	2,258,000	1,457,000	2,663,000	194,900	355,800
(b) Sulphuric Acid	226,000[1]	380,000[1]	14,000	22,000	2,000	3,000
(c) Calcium Carbide and Derivaties	70,000[2]	140,000[2]	224,300	452,500	27,650	56,000
(d) Chlorine and Caustic Soda	-	-	325,000	465,000	46,000	66,000
(e) Chlorate and Perchlorates	-	-	32,000	48,000	4,000	6,000
(f) Carbon Disulfide	25,000	28,000	25,000	28,000	3,200	3,600
(g) Rayon	135,000,000[3]	175,000,000[3]	375,000	490,000	54,000	71,000
Total			2,452,300	4,168,500	331,750	561,400

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[1] 100% acid basis.
[2] Calcium carbide alone.
[3] Pounds.

Chapter VIII - Forest and Forest Product Industries

The logging of timber and the manufacture of wood products have been the major source of industrial employment in the Pacific Northwest. During 1939-1946, logging, sawmill, pulp mill, and related wood products consumed approximately 2 billion kilowatt hours annually.

Since 1909, the region's timber reserve has decrease approximately one-third. Future production of logs and lumber may not be sustained at the wartime rate. Peak wartime production of 12.9 billion board feet in 1941 did not equal the 1929 record cut of 13.5 billion board feet.

The B.P.A. 1960 estimate is based largely on a report of the Forest Service and estimates the lumber production as between 7-1/2 and 9-1/2 billion board feet. The power requirements of this production, including all related forest products industries is estimated at between 2,377, 677,000 and 3,697,811,000 kilowatt hours. The midpoint figure has been taken as the probable load, or 3,038,000,000 kilowatt hours. The demand would be between 691,733 and 1,016,796, or 854,265 kilowatts.

Chapter IX - Agriculture and Food Processing

The future agricultural production and volume of products to be processed in the Northwest will depend to a considerable extent upon general economic conditions. Two sets of assumptions designating two possible levels of economic activity for the country as a whole were used to make estimates of agricultural development in the region. These two levels, of which one is designated "moderate employment" and the other "full employment," indicate a range within which actual development is most likely to fall.

Approximately 53 million acres, or somewhat less than one-third of the total land area is in farms. By 1960 this area would be increased by 2 to 3 million acres. Farming in the Pacific Northwest has undergone a gradual but marked change from so-called extensive types of farming to more intensive type of agricultural production. The anticipated improvements in crop yields, together with the expansion in cropland, are expected to result in major increase in total crop production.

Most outstanding changes are anticipated in dairy, poultry and beef production. Hog production will decline. Many changes in processing of Northwest products may prove feasible but the time or rate at which they will enter into commercial usage is uncertain. A major change in recent years has been the preservation of food by freezing.

All estimates of the agricultural potential of the Columbia Basin are based on the special study prepared by the Bureau of Agricultural Economics of the Department of Agriculture. These estimates of production have been converted into the corresponding power requirements, which result in 513,953,800 to 545,264,800 kilowatt-hours and 234,684 to 248,972 kilowatts by 1960.

Chapter X - Railway Electrification

In 1947 the Great Northern and the Chicago Milwaukee and St. Paul railroads operated 733 miles of electrified main line. Of this total the Great Northern has 73 miles and the Milwaukee the balance, or 660 miles. The Great Northern uses 11,000 volts, 25-cycle, single-phase power, and the Milwaukee uses 3,000 volts D. C. The latter system is not entirely successful because of the excessive voltage drop at heavy loads.

Between 1929 and 1946 there have been 6,231 new Diesel-electric locomotives purchased and only 3,498 steam locomotives. Superiority of the electric drive has been well demonstrated and the question is no longer whether to buy steam or electric locomotives but whether to buy Diesel-electric or all-electric.

The electric locomotive has a higher first cost but due to lower maintenance and higher efficiency the annual cost is less. At 1946 prices, an efficient electrified railroad system may be operated at an estimated annual saving of $52,000 for each locomotive as compared with a Diesel-powered system, provided power could be purchased at 4 mills per kilowatt-hour. At present (1947) the power used by electrified railroads in this region costs 8 to 10 mills, and where electric systems have to be extended, the rates quoted for additional power are as high as 15 mills per kilowatt-hour.

B.P.A. estimates that by 1960 electrification may be extended to a total of 2,000 miles. The power consumption under these conditions would be 720 million kilowatt-hours annually. October coincident demand is estimated at 180,000 kilowatts and the coincident December peak at 160,000 kilowatts.

Chapter XI - Domestic Power Requirements - Urban and Rural

In estimating the number of urban and rural customers in the Pacific Northwest region by 1960, the B.P.A. has necessarily had to estimate also the total population expected to reside in the region at that date. In making this estimate of population, four important changes that have occurred since 1940 have been taken into consideration:

1. The unusually large net in-migration to this region.
2. The intraregional migration from rural to urban areas.
3. The war accelerated industrial growth.
4. Increase in birth rates.

Another important consideration is the fact that the Pacific Northwest has had a more rapid growth than the United States as a whole. The percent of total United States population located in the Northwest has increased from 2.5 percent in 1930 to 3.1 percent in 1946. B.P.A. estimates that this percent will reach 3.3 percent in 1960.

Assuming a total United States population of 151,500,000 in 1960 would result in a population of 5,000,000 for the Pacific Northwest.

In 1940 the average number of persons per occupied dwelling was 3.11 in urban areas, 3.68 on farms and 3.37 in rural nonfarm dwellings. This same ratio is expected to be true in 1960. It is also assumed that by 1960 100 percent of urban dwellings will be electrified and 95 percent of the rural nonfarm and farm.

Using the above mentioned ratios and allowing for unoccupied and nonproductive farms, the total number of customers is given as:

Urban	909,650
Rural Nonfarm	387,385
Rural	184,500

The use per customer has been estimated at 5,500 kilowatt hours per urban and rural nonfarm customer and 10,400 for rural customer. These estimates do not include space heating. Total requirements for 1960 are estimated as:

Urban	5,003 Million kwh
Rural Nonfarm	2,131 " "
Farm	1,920 " "
Total	9,054 " "

In justification of these estimates, B.P.A. points out that in 1946 electric customers in the Pacific Northwest who owned and used major electric appliances such as the electric range, electric water heater and electric refrigerator used 5 to 6 thousand kilowatt hours. Because of the increasing costs of competitive fuels they expect a large percentage of the domestic customers to have these heavy energy consuming devices by 1960 and they also anticipate that other appliances such as ironers, deep freeze chests and air-conditioning systems will be much more widely used in 1960 than at present.

The average annual use per farm of 10,400 kilowatt hours was determined by weighting the total use expected in the various farm types. These were estimated as follows:

Type of Farm	Kwh Per Customer
Farm Home 1/	7,000
Dairy	15,250
Poultry	12,000
General	10,000
Grain	9,750
Fruit and Vegetable	9,450
Livestock	12,250
Seed Crops and Specialties	13,550
Weighted Average	10,400

1/ Subsistence farm. (Apparently the figures for the other farms also include the farm home.)

Chapter XII - Commercial, Small Industrial, Irrigation, Space Heating and Miscellaneous Electric Requirements

A "commercial customer" has been defined as any business establishment not directly engaged in manufacturing. The number of commercial customers has been estimated on the basis of the ratio to domestic customers. In 1935 the ratio was 18 commercial customers per 100 domestic customers in the Pacific Northwest. Even though during the war the ratio dropped to 13.5 percent in 1945, it is expected that by 1960 the ratio will be back at 18 percent.

The average annual consumption has risen from 8,400 kilowatt hours in 1939 to 13,860 kilowatt hours per customer in 1947. Using a rate of increase of 5.5 percent compounded annually, B.P.A. arrives at a use per customer of 27,000 kilowatt hours in 1960. The total commercial requirements for 1960 are estimated at 7,200 million kilowatt hours.

The industrial load has been divided into large and small industrial establishments depending on whether they use more or less than 4 million kilowatt hours per year. Small industrial customers have been estimated on the basis of one customer to each 20 commercial customers which was the ratio in 1945. Applying this ratio to the number of commercial customers previously estimated, there would be about 13,330 small industrial customers in 1960. The average use for the small industrial customer in 1946 was 225,945 kilowatt hours. B.P.A. estimates that this will increase to 300,000 kilowatt hours by 1960.

From the above estimates of customers and use per customer the total 1960 requirements for small industry amounts to 3,999 million kilowatt hours. This does not include small forest industry plants but does include food processing plants.

The space-heating load has been estimated on the basis of past trends for use of resistance type heaters and the probability that most of the resistance heaters will be replaced by the heat pump. It has been assumed that by 1960 10 percent of the homes in the Pacific Northwest will make use of the "heat pump". Total requirements, assuming heat pump use of 4,500 kilowatt hours per home heated, are estimated at 667 million kilowatt hours.

Irrigation pumping, aside from the use of individuals and small groups of farm operators, is made up almost entirely by the irrigation requirements of U. S. Bureau of Reclamation projects. The latter are estimated at 1,902 million kilowatt hours in 1960, making the total estimated irrigation pumping requirements 2,286 million kilowatt hours.

Street and highway lighting requirements per capita of urban population in 1947 amounted to 40 kilowatt hours. It is expected that by 1960 the use per capita will be doubled and 226 million kilowatt hours will be used for all street and highway lighting in the region.

Miscellaneous requirements such as the requirements of public agencies for domestic water pumping, storage treatment plants, lighting of recreational areas and municipal buildings, use by military establishments and construction enterprises is estimated as 800 million kilowatt hours in 1960. This was estimated on the basis of historical trends in per capita requirements. It was 57 kilowatt hours in 1937, 100 kilowatt hours in 1947, and was estimated to be 160 kilowatt hours in 1960.

PART II - LOAD ESTIMATES

Introduction

This section of the report presents the results of a study to determine the probable power requirements in the Pacific Northwest region to the year 1960. Although the study was made primarily to check the reasonableness of estimates made in the Bonneville Power Administration's report entitled "Power Markets and Developments in the Pacific Northwest", it will be a valuable adjunct to the Commission's continuing studies of power requirements and supply.

In the following pages a brief analysis is made of (1) the past and future trends of population; (2) past and probable future use of farm, residential and commercial customers; (3) the industrial energy consumption trends modified by the anticipated development of the region's natural resources; and (4) numerous other factors that might affect the power requirements of the region.

Region Considered

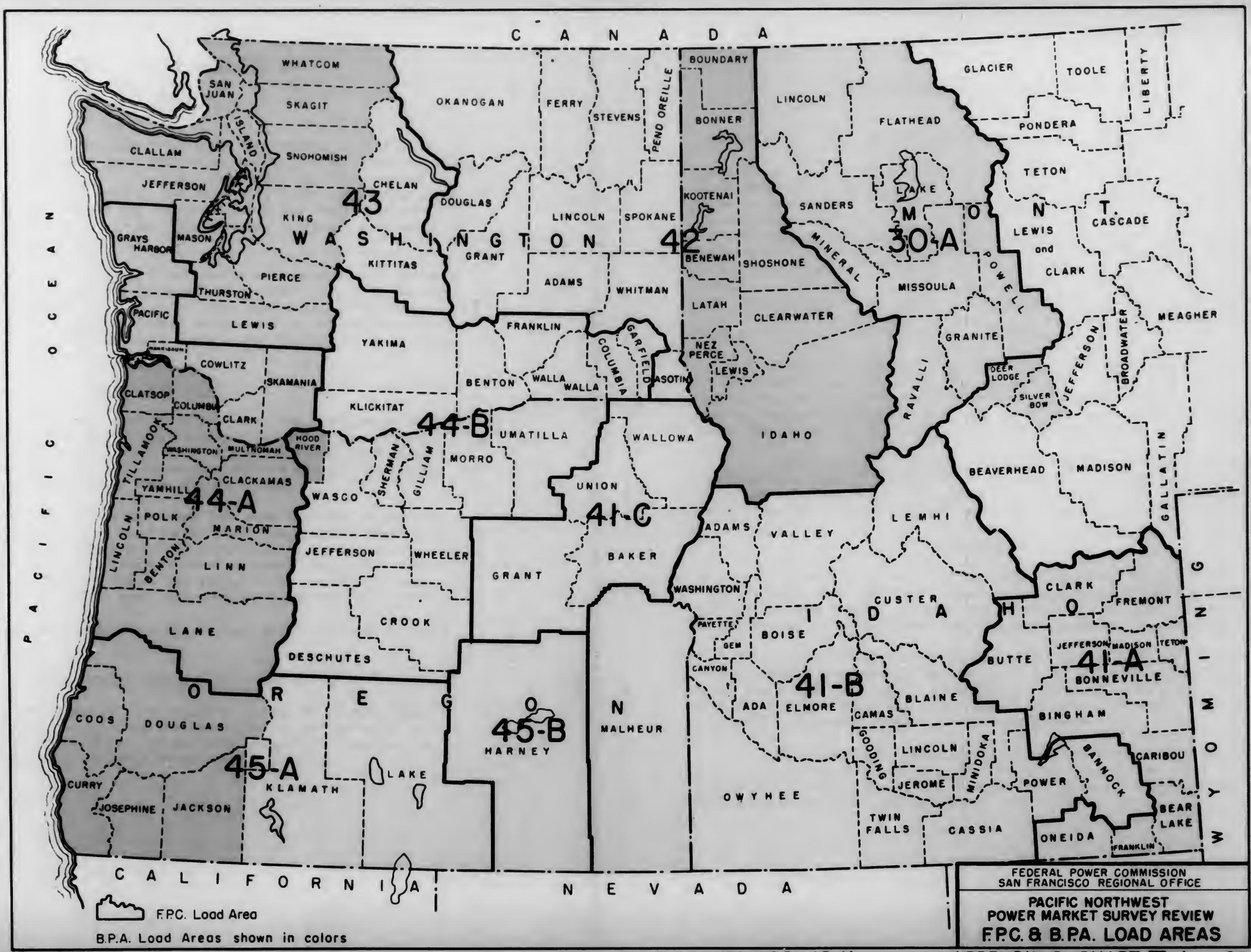
The region has been subdivided into ten load areas which correspond to Federal Power Commission Power Supply Areas and Subareas 41-B, 41-C, 42, 43, 44-A, 44-B, 45-B, that part of 41-A in Idaho, that part of 45-A in Oregon and 30-A, which includes nine western counties in Montana as adopted in the Missouri River Power Market Survey.

This division of load areas has been made in order to utilize data available in the files of the Federal Power Commission. Exact comparisons cannot be made between F.P.C. and B.P.A. load areas due to slight differences in the territory included by each. The totals are not exactly comparable either, as B.P.A. has included two counties in western Montana (Deer Lodge and Silver Bow), which were not included by the F.P.C.

A comparison of B.P.A. and F.P.C. load areas is shown on Chart II-1.

Principal Economic Activities

Prior to World War II, the region's economy was founded primarily on agricultural pursuits and the production of raw material for export. The general character of the economic activity in the area is indicated in the tabulation of wage earners which follows:



F.P.C. Load Area

B.P.A. Load Areas shown in colors

FEDERAL POWER COMMISSION
SAN FRANCISCO REGIONAL OFFICE

PACIFIC NORTHWEST
POWER MARKET SURVEY REVIEW
F.P.C. & B.P.A. LOAD AREAS

Wage Earners (14 or More Years of Age)

1940

Industry	Washington	Oregon	Idaho	Total
Agriculture	83,475	71,335	58,130	212,940
Manufacturing	74,939	37,859	6,905	119,703
Trade or Commercial	285,576	174,234	60,363	520,173
Transportation and Communication	51,515	30,803	10,428	92,746
Building	37,441	20,700	7,187	65,328
Forestry and Fishing	61,025	45,765	6,386	113,176
Mining	5,429	2,953	6,735	15,117
Other Industries	8,272	6,149	2,472	16,893
Totals	607,672	389,798	158,606	1,156,076

While data for year 1940 (the latest for which complete records are available) do not show the present magnitude of operations, and fail to indicate the character and extent of the changes during the war years, they do provide a reasonable accurate basis for determining the general nature and distribution of economic activities throughout the area.

Since the B.P.A.'s report on "Power Markets and Developments in the Pacific Northwest" covers in detail activities in agriculture and food processing, forest and forest products industries, mining and various other industries, these need not be further discussed in this section.

Population

The population of a region is one important indication of the region's power requirements. Therefore, population estimates based on past and present trends, distribution, density and expected changes in economic conditions are useful tools in estimating future power requirements.

In the Pacific Northwest the population in 1890 was 777,911. By 1940 the region's population had grown to 3,457,021 persons, and the estimated population for 1947 was 4,329,000 persons. Of this number, 52 percent resided in Washington; 35 percent in Oregon; 11 percent in Idaho; and 2 percent in the nine western counties in Montana.

The population increase that has occurred during the past 50 years has been material in size and constantly progressive. The following tabulation indicates the extent of decennial increases between 1890 and 1940 and the estimated population in 1947:

Population of Pacific Northwest
1890-1947

Year	Washington	Oregon	Idaho	Montana (9 Western Counties)	Total
1890	357,232	317,704	88,548	14,427	777,911
1900	518,103	413,536	161,772	35,489	1,128,900
1910	1,141,990	672,765	325,594	70,244	2,210,593
1920	1,356,621	783,389	431,866	81,947	2,653,823
1930	1,563,396	953,786	445,032	84,460	3,046,674
1940	1,736,191	1,089,684	524,873	106,273	3,457,021
1947	2,233,000	1,517,000	488,000	91,000	4,329,000

The shift in the production of lumber from the Great Lakes region to the Pacific Northwest caused the large increase of population in the 1900-1910 decade. From 1910 to 1940 the population growth was rather steady.

World War II effected the greatest change thus far in the population of the region. The development of huge water-power projects and the location of large war materials industries and shipbuilding have contributed to an increase in population by 1947 as large and in some cases even larger than was expected by 1960, in estimates made as late as 1942.

Population data from 1890 to 1945 are shown by F.P.C. subareas on Table No. II-1.

The 1940 distribution of the region's population between urban, rural nonfarm and rural farm localities in the various subareas is shown, on a percentage basis, on Table No. II-2. Comparable data for the United States as a whole are also included. It is to be noted that 48.11 percent of the region's population was classified as urban in 1940 as compared to 56.52 percent for the nation.

The population of the Pacific Northwest is concentrated largely in the Puget Sound and the Willamette Valley sections west of the Cascade Mountains. In 1940, four communities accounted for 25.7 percent of the population of the region.

Community	1940 Population	P.S.A.
Seattle, Washington	368,302	43
Portland, Oregon	305,394	44-A
Spokane, Washington	122,001	42
Tacoma, Washington	109,408	43
Total	905,105	

Table No. II-1

Federal Power Commission
San Francisco Regional Office

Pacific Northwest Review Report

PAST POPULATION

Area or Subarea	1890	1900	1910	1920	1930	1940	1945 1/
	Reported Population						
30-A	14,427	35,489	70,244	81,947	84,460	106,273	96,526
41-A	25,124	37,348	80,751	99,892	97,508	109,317	104,502
41-B	39,530	74,545	152,315	230,386	238,853	299,547	302,481
41-C	24,765	40,473	45,719	49,839	48,000	49,699	44,092
42	100,570	181,880	369,012	383,777	387,906	432,581	443,477
43	203,497	293,315	672,986	848,012	999,760	1,103,151	1,327,956
44-A	230,757	303,703	547,865	658,274	826,729	931,704	1,230,803
44-B	74,433	105,286	179,430	207,625	222,288	257,576	310,236
45-A	46,307	54,264	88,212	90,078	135,251	161,799	172,686
45-B	2,559	2,598	4,059	3,992	5,920	5,374	4,597
Northwest Region	761,969 2/	1,128,900	2,210,593	2,653,822	3,046,675	3,457,021	4,037,356

1/ Estimate based on 1943 distribution by counties (U. S. Bureau of the Census).
2/ Does not include 15,942 Indians living in reservations (Total: 777,911).

Table No. II-2

Federal Power Commission
San Francisco Regional Office

Pacific Northwest Review Report

PERCENT DISTRIBUTION OF POPULATION BY AREAS

1940

Area or Subarea	Urban	Rural		
		Total	Nonfarm	Farm
30-A	30.65	69.35	36.43	32.92
41-A	31.70	68.30	23.02	45.28
41-B	35.58	64.42	25.25	39.17
41-C	34.38	65.62	33.23	32.39
42	41.15	58.85	30.94	27.91
43	59.01	40.99	26.02	14.97
44-A	53.65	46.35	26.26	20.09
44-B	32.75	67.25	32.62	34.63
45-A	34.81	65.19	37.40	27.79
45-B	47.75	52.25	23.39	28.86
Total Pacific NW Region	48.11	51.89	27.98	23.91
Total United States 1/	56.52	43.48	20.53	22.95

Source: U. S. Census for 1940.

1/ 16th Census of the U. S., 1940, Series P-10, No. 2, February 27, 1942.

Of these four cities, Seattle, Portland and Tacoma, are located west of the Cascades, while Spokane constitutes the most important population center in the "Inland Empire".

Outside the Puget Sound-Cowlitz-Willamette districts, the population centers are located in the vicinity of irrigated valleys such as the Yakima, Wenatchee and Walla Walla districts in Washington; the Hood River, Umatilla, Klamath and Rogue River districts in Oregon; the Reclamation districts along the Snake River such as Payette, Boise, Minidoka, etc., in Idaho; and the Kalispell and Missoula districts in western Montana.

The remainder of the region is sparsely settled due principally to the arid or mountainous nature of its terrain.

Population Estimates

The population in Washington, Idaho and in Oregon increased from about 3,351 thousand persons in 1940 to about 4,238 thousand in 1947, an increase of 26.5 percent caused principally by a net in-migration of about 600,000 persons. Most of this in-migration was caused by war-accelerated industrial growth, much of which has become permanently established.

There has also been a considerable shift in population during the war years from the rural areas to the urban areas. About 792,000 persons in the three states in 1940 were living on farms. This population decreased to about 741,000 in 1945. .

In making estimates of the 1960 population the Bureau of the Census report, "Forecast of the Population of the United States 1945-1975", has been used as a guide. The Bureau of Census has estimated an increase of 11.1 percent for the United States from 1945 to 1960. This estimate is on the basis of medium fertility and mortality and 500,000 net immigration during each five-year period.

In view of the past growth of population in the Pacific Northwest in relation to the United States as a whole; the rapid increase in population in the area during the war years; and the anticipated increase in industry in the future, it is estimated that the growth in this area will be considerably greater than for the nation as a whole. From 1940 to 1945 the percentage increase of the region was almost three times as great as for the nation. It is estimated that the increase of the region between 1945 and 1960 will be 22.1 percent.

Table No. II-3 shows the past and estimated 1960 population for the Pacific Northwest region and its relation to the population of the United States. It also shows the percentage growth between census years and that estimated for the future.

Table No. II-4 shows by F.P.C. subareas the 1930 and 1940 population by urban, rural nonfarm and farm classifications and the estimated population by these classifications for 1960. Also shown is the 1945 farm population. In determining the distribution of population in 1960, consideration was given to the additional farms which will be created by proposed Reclamation projects in the Pacific Northwest.

Table No. II-3

Federal Power Commission
San Francisco Regional Office

Pacific Northwest Review Report

PAST AND ESTIMATED 1960 POPULATION
PACIFIC NORTHWEST 1/ AND NATION

Year	Population Pacific Northwest	Percent Increase	Population of the United States	Percent Increase
1890	761,969		62,947,714	
1900	1,128,900	48.2	75,994,575	20.7
1910	2,210,593	95.8	91,972,266	21.0
1920	2,653,822	20.1	105,710,620	14.9
1930	3,046,675	14.8	122,775,046	16.1
1940	3,457,021	13.5	131,669,275	7.2
1945	4,037,356	16.8	139,621,000	6.0
1947	2/		142,186,000	
Estimated 1960	4,930,000	22.1 3/	155,075,000	11.1 3/

1/ Does not include Deer Lodge and Silver Bow Counties in Montana which are included in B.P.A. report.
2/ Not available for area. Population of Washington, Oregon and Idaho is 4,199,000.
3/ Increase over 1945.

Table No. II-4

Federal Power Commission
San Francisco Regional Office

Pacific Northwest Review Report

DISTRIBUTION OF POPULATION
PAST AND ESTIMATED FUTURE

Area or Subarea	1930				1940				1945	Estimated 1960			
	Urban	Rural			Urban	Rural			Rural	Urban	Rural		
		Total	Non-farm	Farm		Total	Non-farm	Farm	Farm		Total	Non-farm	Farm
30-A	27,064	57,396	29,951	27,445	32,574	73,699	38,711	34,988	27,500	44,680	65,320	35,320	30,000
41-A	24,370	73,138	23,996	49,142	34,652	74,665	25,166	49,499	48,276	44,790	74,900	33,030	41,870
41-B	71,913	166,940	62,353	104,587	106,566	192,441	75,647	117,334	108,024	177,210	228,100	105,770	122,330
41-C	15,908	32,092	14,876	17,216	17,089	32,610	16,514	16,096	13,600	19,160	33,430	20,010	13,420
42	160,260	227,646	114,869	112,777	178,005	254,576	133,822	120,754	103,500	325,430	333,290	229,450	103,840
43	635,395	364,365	224,176	140,189	650,972	452,179	287,047	165,132	161,200	947,110	562,440	401,700	160,740
44-A	469,661	357,068	200,235	156,833	499,814	431,890	244,666	187,224	180,700	959,160	510,840	312,720	198,120
44-B	70,984	151,304	62,905	88,399	84,366	173,210	84,022	89,188	77,200	148,020	201,750	125,870	75,880
45-A	52,703	82,548	46,058	36,490	56,322	105,477	60,506	44,971	46,700	114,000	135,000	85,500	49,500
45-B	2,599	3,321	1,166	2,155	2,566	2,808	1,257	1,551	1,600	2,120	3,250	1,950	1,300
Pacific Northwest Region	1,530,857	1,515,818	780,585	735,233	1,662,926	1,794,095	967,358	826,737	768,300	2,781,680	2,148,320	1,351,320	797,000

Past Power Requirements

The information on past utility requirements was obtained from annual Power System Statements filed with the Commission by the electric power systems of the region, and from data which had been compiled by the Commission in previous studies relating to the area. Data in regard to industrial power generation and use were secured principally from Commission published and unpublished tabulations of the results of questionnaires to industrial establishments. The coverage can be considered complete for all practical purposes, since requirements of any small utilities or industries not included in the data are estimated to be less than one-half of one percent of the total load of the region.

Historical Trends and Power Requirements

Electric power use is recognized as an excellent indicator of the trend of the nation's industrial economy. In general, the power requirements of the region during the past years have reflected the prevailing business and economic conditions.

The past power requirements by subareas, areas and for the region are shown on Table No. II-5 for the period 1929 through 1946. The table includes data for utilities and also for industrial plants which have their own generation. Records of industrial plants do not cover the entire period, but are fairly complete from 1939 through 1945. This table also gives the total power requirements for the region under study from 1902 to 1946.

As will be noted from the data in Table No. II-5, the energy requirements of the utility systems dropped off in the years 1931 to 1935, the minimum for the region being 3,577 million kilowatt hours for the year 1933. This is a reduction of about 14.3 percent from the previous high of 4,176 million kilowatt hours reached in 1930. However, except for these depression years and the brief decline after the end of World War II, there has been a steady growth throughout the past. The wartime high of 16,107 million kilowatt hours with a corresponding maximum demand of 2,681 thousand kilowatts was reached in 1944. Energy requirements fell off to 15,097 million kilowatt hours in 1945 and 14,646 million kilowatt hours in 1946 due to the termination of hostilities and decline in heavy industrial use, particularly aluminum reduction. However, the maximum demand in the region reached an all-time high in 1946 of 2,988 thousand kilowatts. The utility energy requirements for the year 1947 exceeded the maximum requirements of 1944.

In addition to the utility requirements discussed above, industrial plant generation for own use was more than a billion kilowatt hours annually between 1939 and 1945.

Table No. II-5
Sheet 1 of 6

Table No. II-5
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Pacific Northwest Review Report
Past Power Requirements

	Utility Systems		Industrial Plants 1/		Utility Systems		Industrial Plants 1/	
Year	Energy Million Kwh	Demand 1,000 Kw2/	Energy Million Kwh	Demand 1,000 Kw2/	Energy Million Kwh	Demand 1,000 Kw4/	Energy Million Kwh	Demand 1,000 Kw4/
	Subarea 30-A				Subarea 41-A3/			
1929	153.2				34.1			
1930	123.4				40.2			
1931	89.8				41.1			
1932	58.6				40.3			
1933	85.2				41.3			
1934	79.9				48.9			
1935	111.5				46.6			
1936	124.8				51.3			
1937	131.8				59.3			
1938	105.2				64.7			
1939	128.0	32.5	13.6	5.3	72.3	14.2	0.9	0.8
1940	158.7	40.3	16.8	5.8	77.1	14.7	1.2	0.8
1941	177.0	44.7	19.9	6.2	76.9	15.7	1.0	0.8
1942	175.5	44.2	22.3	6.4	83.0	14.9	0.9	0.8
1943	184.0	46.2	21.4	6.7	87.8	15.2	1.2	0.8
1944	209.7	52.4	22.1	6.6	92.7	17.6	0.1	0.8
1945	220.0	54.8	23.3	7.0	101.5	20.2	0.7	0.8
1946	209.8	53.9	-	-	131.6	24.6	-	-

1/ Generation for own use.
2/ Non-coincident peak loads. Utility load partially estimated.
3/ That part in Idaho only.
4/ Non-coincident peak loads.

Table No. II-5
Sheet 2 of 6

Table No. II-5
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Past Power Requirements

	Utility Systems		Industrial Plants 1/		Utility Systems		Industrial Plants 1/	
Year	Energy Million Kwh	Demand 1,000 Kw 2/	Energy Million Kwh	Demand 1,000 Kw 2/	Energy Million Kwh	Demand 1,000 Kw 2/	Energy Million Kwh	Demand 1,000 Kw 2/
	Subarea 41-B				Subarea 41-C			
1929	269.0				19.1			
1930	297.8				19.6			
1931	316.3				18.5			
1932	287.1				16.5			
1933	280.2				15.4			
1934	283.5				16.6			
1935	310.0				20.8			
1936	338.8				27.5			
1937	377.1				29.0			
1938	388.5				29.5			
1939	425.2	98.8	21.0	8.8	31.5	7.5	1.2	0.6
1940	441.6	91.5	24.9	9.1	36.0	8.4	1.5	0.8
1941	471.4	89.1	23.1	9.9	39.2	8.7	1.6	0.8
1942	489.3	94.7	28.9	11.9	37.2	8.9	1.8	0.9
1943	530.5	101.6	29.7	11.9	32.5	7.3	2.0	1.0
1944	581.2	111.7	17.5	11.3	34.8	8.2	2.0	1.0
1945	623.0	131.6	18.6	9.4	40.0	9.8	1.5	1.0
1946	706.3	148.1	-	-	52.6	13.0	-	-

1/ Generation for own use.
2/ Non-coincident peak loads.

Table No. II-5
Sheet 3 of 6

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Pacific Northwest Review Report
Past Power Requirements

	Utility Systems		Industrial Plants 1/		Utility Systems		Industrial Plants 1/	
Year	Energy Million Kwh	Demand 1,000 Kw 2/	Energy Million Kwh	Demand 1,000 Kw 2/	Energy Million Kwh	Demand 1,000 Kw 2/	Energy Million Kwh	Demand 1,000 Kw 2/
	Area 42				Area 43			
1929	672.4				1,517.4			
1930	664.1				1,596.6			
1931	622.1				1,516.8			
1932	548.3				1,383.2			
1933	532.2				1,340.8			
1934	606.3				1,443.2			
1935	641.5				1,516.8			
1936	737.3				1,699.0			
1937	833.9				1,897.0			
1938	750.9				1,817.5			
1939	954.9	160.2	27.7	10.3	2,026.8	444.4	522.1	125.0
1940	1,084.7	197.5	31.8	11.1	2,223.1	482.3	553.9	129.0
1941	1,108.1	179.6	39.4	19.5	2,603.1	447.4	605.4	135.0
1942	1,516.6	260.0	64.0	20.3	3,227.1	632.9	656.9	141.8
1943	2,742.2	519.6	74.6	19.0	4,102.0	782.8	569.4	140.8
1944	3,427.9	487.2	42.9	22.1	4,487.0	817.7	493.8	136.3
1945	2,562.3	469.2	45.3	21.7	4,541.7	880.2	490.6	135.4
1946	2,028.3	495.2	-	-	4,438.1	924.2	-	-

1/ Generation for own use.
2/ Non-coincident peak loads.

Table No. II-5
Sheet 4 of 6

Table No. II-5
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San Francisco Regional Office
Pacific Northwest Review Report
Past Power Requirements

Year	Utility Systems Energy Million Kwh	Utility Systems Demand 1,000 Kw2/	Industrial Plants 1/ Energy Million Kwh	Industrial Plants 1/ Demand 1,000 Kw2/	Utility Systems Energy Million Kwh	Utility Systems Demand 1,000 Kw2/	Industrial Plants 1/ Energy Million Kwh	Industrial Plants 1/ Demand 1,000 Kw2/
	Subarea 44-A				Subarea 44-B			
1929	1,081.5				158.4			
1930	1,082.9				176.0			
1931	1,050.3				180.6			
1932	979.0				170.6			
1933	971.1				172.2			
1934	1,059.6				188.1			
1935	1,153.0				193.2			
1936	1,281.4				207.3			
1937	1,386.9				234.9			
1938	1,347.4				239.8			
1939	1,518.3	336.6	349.5	94.5	262.6	54.4	47.3	15.2
1940	1,797.9	433.4	369.5	98.1	287.6	56.9	48.7	16.1
1941	3,202.0	649.0	410.3	108.5	311.6	63.2	52.6	16.4
1942	4,777.0	797.8	398.2	110.5	344.0	63.6	48.1	15.9
1943	6,036.0	939.8	435.3	108.6	403.2	76.5	47.1	16.0
1944	6,367.0	987.5	400.2	109.1	597.8	130.8	44.6	17.2
1945	5,753.2	971.3	348.0	102.5	927.6	152.6	39.5	15.6
1946	5,718.7	1,063.9	-	-	956.9	176.2	-	-

1/ Generation for own use.
2/ Non-coincident peak loads.

Table No. II-5
Sheet 5 of 6

Table No. II-5
Federal Power Commission
San Francisco Regional Office
Pacific Northwest Review Report
Past Power Requirements

Year	Utility Systems Energy Million Kwh	Utility Systems Demand 1,000 Kw2/	Industrial Plants 1/ Energy Million Kwh	Industrial Plants 1/ Demand 1,000 Kw2/	Utility Systems Energy Million Kwh	Utility Systems Demand 1,000 Kw2/	Industrial Plants 1/ Energy Million Kwh	Industrial Plants 1/ Demand 1,000 Kw2/
	Subarea 45-A 3/				Subarea 45-B			
1929	166.3				0.8			
1930	174.1				1.2			
1931	171.5				1.3			
1932	142.2				1.1			
1933	138.1				1.0			
1934	149.1				1.1			
1935	165.4				1.1			
1936	186.3				1.3			
1937	200.5				1.5			
1938	195.1				1.7			
1939	213.9	43.0	56.1	21.5	2.1	0.5	15.9	3.9
1940	234.9	48.5	62.1	21.3	2.5	0.7	14.9	3.8
1941	265.0	51.8	72.0	22.3	2.7	0.8	14.1	3.8
1942	282.2	54.4	70.9	22.9	2.8	0.7	14.3	3.8
1943	294.5	60.8	68.0	22.5	2.7	0.7	18.2	3.8
1944	306.5	66.8	66.6	23.1	2.8	0.7	13.2	3.8
1945	324.6	68.6	49.4	22.9	2.9	0.7	10.3	3.8
1946	399.7	88.0			3.9	0.9		

1/ Generation for own use.
2/ Non-coincident peak loads.
3/ That part in Oregon only.

Table No. II-5
Federal Power Commission
San Francisco Regional Office
Pacific Northwest Review Report
Past Power Requirement

Year	Utility Systems	Year	Utility Systems		Industrial Plants 1/	
	Energy Million Kwh		Energy Million Kwh	Demand 1,000 Kw 2/	Energy Million Kwh	Demand 1,000 Kw 2/
	Pacific Northwest Region Totals					
1902	70.3	1931	4,008.3			
1907	385.8	1932	3,626.9			
1912	812.6	1933	3,577.5			
1917	1,443.3	1934	3,876.3			
1920	2,004.2	1935	4,159.9			
1921	1,944.7	1936	4,655.0			
1922	2,128.6	1937	5,151.9			
1923	2,404.4	1938	4,940.3			
1924	2,534.6	1939	5,635.6	1,192.1	1,055.3	285.9
1925	2,812.0	1940	6,344.1	1,374.2	1,125.3	295.9
1926	3,257.8	1941	8,257.0	1,550.0	1,239.4	323.2
1927	3,493.5	1942	10,934.7	1,972.1	1,306.3	335.2
1928	3,894.7	1943	14,415.4	2,550.5	1,266.9	331.1
1929	4,072.2	1944	16,107.4	2,680.6	1,103.0	331.3
1930	4,175.9	1945	15,096.8	2,759.0	1,027.2	320.1
		1946	14,645.9	2,988.0		

1/ Generation for own use.
2/ Non-coincident peak loads.
Note: Requirements prior to 1926 do not include Power Supply Subarea 30-A.

Estimates of Future Loads

The rate of growth of electric power loads have been estimated by considerations of such factors as low-cost power, probable industrial and economic developments in the region, and past trends of electric energy requirements.

The estimates of the energy use in 1960 for each classification are discussed in the following paragraphs.

Future Sales to Rural and Residential Customers

In a study of past sales of energy to rural and domestic customers, as reported by utilities to the F.P.C., it was found that the method of classifying sales varied between utilities and also from period to period. In some cases energy sold to urban and rural customers was reported as sales to domestic customers. In other cases where these sales were previously reported separately, they were later combined as one classification. For these reasons, it was necessary to combine rural and residential sales as one classification in order to show a true trend of past use.

Future rural and residential power requirements have been estimated on the basis of the number of electrified homes in relation to the population and the expected annual use per customer based on past trends. The following paragraphs indicate in detail the method used in arriving at an estimate of the number of customers and the annual use per customer in 1960.

In 1940 the average number of persons per occupied dwelling was 3.11 in urban areas, 3.68 on farms and 3.37 in rural nonfarm dwellings. These ratios were used for estimating the potential number of occupied dwellings in the region in 1960. All urban occupied dwellings were considered as being electrified in 1960 and 95 percent of the rural nonfarm and farm dwellings. A slight adjustment has been made in farm customers to allow for farms that have more than one dwelling.

The average annual use per rural and residential customer for the region has more than doubled in a period of six years, increasing from 1,586 kilowatt hours in 1940 to 3,190 kilowatt hours in 1946. The use per customer and the rate of growth has varied considerably in the various power supply areas. In 1940 the lowest use was 1,061 kilowatt hours in Subarea 45-B, while the highest was 2,170 kilowatt hours in Subarea 45-A. In 1946 the low was 1,840 kilowatt hours in Subarea 41-C and the high was 3,639 kilowatt hours in Power Supply Area 42. The least increase in use per customer (36 percent) between 1940 and 1946 was in Subarea 41-A. The greatest increase in this period was in Power Supply Area 43 where the use per customer increased 116 percent. It is estimated that average annual use per customer, for the region, in 1960 will be about twice the annual use in 1946. This estimate is based in part on the expected increase in residential use of electric energy for space heating.

Table No. II-6
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San Francisco Regional Office
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PAST AND ESTIMATED FUTURE ENERGY REQUIREMENTS
RURAL AND RESIDENTIAL CUSTOMERS
(1930-1946, Actual: 1960, Estimated)

Area or Subarea		1930	1935	1940	1941	1942	1943	1944	1945	1946	1960
41-A	Number of Customers	10,258	11,423	14,856	16,590	17,049	17,036	17,028	17,360	18,806	33,810
	Use per Customer 1/	1,060	1,169	1,946	1,845	1,933	1,973	2,097	2,339	2,651	4,520
	Total Use 2/	10,870	13,578	28,903	30,604	32,963	33,616	35,710	40,604	49,860	152,800
41-B	Number of Customers	33,263	38,405	61,229	64,605	63,696	65,218	67,852	72,099	78,708	115,900
	Use per Customer 1/	1,676	1,396	1,877	2,009	2,226	2,364	2,496	2,640	2,937	4,970
	Total Use 2/	55,762	53,623	114,906	129,821	141,773	154,177	169,364	190,342	231,194	576,000
41-C	Number of Customers	-	-	8,677	8,976	8,976	9,192	9,378	9,603	10,350	15,200
	Use per Customer 1/	-	-	1,064	1,183	1,287	1,341	1,439	1,590	1,840	3,710
	Total Use 2/	4,100	4,800	9,233	10,616	11,556	12,327	13,493	15,269	19,047	56,400
42	Number of Customers	-	-	91,435	88,878	89,530	90,210	94,094	96,955	104,101	195,500
	Use per Customer 1/	-	-	1,749	2,126	2,369	2,726	2,934	3,155	3,639	6,975
	Total Use 2/	108,400	107,900	159,893	188,947	212,066	245,891	276,056	305,940	378,774	1,363,600
43	Number of Customers	-	-	303,932	321,416	333,973	347,172	354,129	366,577	376,810	453,800
	Use per Customer 1/	-	-	1,566	1,855	2,225	2,500	2,718	2,998	3,390	6,670
	Total Use 2/	273,039	286,805	476,083	596,349	743,057	867,818	962,461	1,098,948	1,277,360	3,026,700
44-A	Number of Customers	-	-	223,667	238,077	248,693	249,951	256,539	264,985	278,601	438,800
	Use per Customer 1/	-	-	1,433	1,583	1,843	2,187	2,332	2,580	3,097	6,450
	Total Use 2/	154,900	179,100	320,503	376,886	458,351	546,524	598,328	683,544	862,832	2,830,200
44-B	Number of Customers	-	-	63,759	67,269	67,948	67,561	70,545	67,979	71,255	102,300
	Use per Customer 1/	-	-	1,461	1,531	1,663	1,838	1,927	2,282	2,793	5,170
	Total Use 2/	44,000	53,900	93,136	102,962	113,031	124,174	135,965	155,098	199,038	528,900
45-A	Number of Customers	22,264	23,157	32,064	34,170	34,335	34,433	34,697	36,926	39,157	73,130
	Use per Customer 1/	2,045	1,878	2,170	2,272	2,433	2,617	2,819	2,917	3,371	5,830
	Total Use 2/	45,539	43,495	69,577	77,638	83,529	90,106	97,797	107,723	131,985	426,300
45-B	Number of Customers	-	575	857	814	890	882	890	835	880	1,560
	Use per Customer 1/	-	656	1,061	1,260	1,209	1,262	1,303	1,448	1,916	3,205
	Total Use 2/	-	377	909	1,026	1,076	1,113	1,160	1,209	1,686	5,000
Subtotal	Number of Customers	-	-	800,476	840,805	865,090	881,655	905,152	933,319	978,668	1,430,000
	Use per Customer 1/	-	-	1,590	1,802	2,078	2,354	2,530	2,784	3,220	6,270
	Total Use 2/		743,579	1,273,143	1,514,849	1,797,402	2,075,746	2,290,374	2,598,377	3,151,776	8,965,900
30-A	Number of Customers	-	-	22,772	-	-	-	-	22,402	24,955	30,900
	Use per Customer 1/	-	-	1,416	-	-	-	-	1,909	2,006	3,563
	Total Use 2/	-	-	32,294	-	-	-	-	42,765	50,068	110,100
Total Pac. NW Region	Number of Customers	-	-	823,248	-	-	-	-	955,721	1,003,623	1,460,900
	Use per Customer 1/	-	-	1,586	-	-	-	-	2,764	3,190	6,213
	Total Use 2/	-	-	1,305,437	-	-	-	-	2,641,442	3,201,844	9,076,000

1/ Kw-hr per customer. 2/ 1000 kw-hrs.

Table No. II-6 shows, by power supply areas, the number of customers, use per customer and total use for rural and residential customers for certain past years and estimates for 1960.

Estimated Future Sales to Commercial Customers

Sales of electric power to wholesale and retail stores, to personal service, offices and establishments, repair shops, amusement and recreation establishments, restaurants, hotels, etc., for lighting, heating, cooking, the operation of small motors, and for similar uses, are included under the classification "commercial sales".

Growth in the volume of energy sold to commercial customers in the region has been steady (except for a few years during the decade 1930-1940). The annual use of electric energy by commercial establishments in 1930 was over 575 million kilowatt hours and by 1945 the annual use amounted to 1,464 million kilowatt hours, about 2.5 times the 1930 requirements. It is estimated that continued expansion of population and commercial business in the region will bring the total annual use of electricity for this purpose to about 3,812 million kilowatt hours in 1960, approximately 2.6 times the 1945 total.

Table No. II-7 shows the past and estimated 1960 commercial use for each of the load areas. The use per capita and the use per customer shown on the table were factors used in making the estimates. Consideration was also given to the ratio of domestic to commercial requirements, and past trends of growth in the commercial classification.

Sheet 1 of 2

Table No. 11-7

Federal Power Commission
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COMMERCIAL ENERGY REQUIREMENTS
(1930-1946 Actual; 1960 Estimated)

Area or Subarea		1930	1935	1940	1941	1942	1943	1944	1945	1946	1960
41-A	Population	97,508	-	109,317	-	-	-	-	104,502	-	119,690
	Number of Customers	1,670	-	2,148	2,119	3,067	3,008	2,643	2,717	2,859	4,360
	Use per Customer 1/	1,823	-	4,127	3,704	2,776	2,737	3,388	3,828	4,540	7,800
	Use per Capita 1/	31	-	81	-	-	-	-	100	-	284
	Total Use 2/	3,044	4,432	8,865	7,848	8,514	8,233	8,955	10,402	12,980	34,000
41-B	Population	238,853	-	299,547	-	-	-	-	302,481	-	405,310
	Number of Customers	-	-	10,745	10,297	9,687	10,648	11,081	11,455	11,855	16,900
	Use per Customer 1/	-	-	6,109	6,571	7,312	5,735	6,085	6,552	7,857	11,850
	Use per Capita 1/	106	-	219	-	-	-	-	248	-	494
	Total Use 2/	25,300	24,100	65,639	67,663	70,830	61,070	67,428	75,048	93,150	200,300
41-C	Population	48,000	-	49,699	-	-	-	-	44,092	-	52,590
	Number of Customers	-	-	1,760	1,795	1,779	1,712	1,774	1,715	2,014	2,500
	Use per Customer 1/	-	-	3,387	3,733	3,189	3,165	3,413	4,914	4,956	7,520
	Use per Capita 1/	62	-	120	-	-	-	-	191	-	357
	Total Use 2/	3,000	2,600	5,961	6,700	5,674	5,418	6,055	8,427	9,982	18,800
42	Population	387,906	-	432,581	-	-	-	-	443,477	-	658,720
	Number of Customers	-	-	17,579	15,756	14,945	13,321	13,338	13,898	15,328	26,350
	Use per Customer 1/	-	-	7,066	5,343	5,968	9,753	10,092	10,799	11,672	19,600
	Use per Capita 1/	167	-	287	-	-	-	-	338	-	784
	Total Use 2/	64,800	62,400	124,206	84,186	89,186	129,916	134,608	150,079	178,902	516,500
43	Population	999,760	-	1,103,151	-	-	-	-	1,327,956	-	1,509,550
	Number of Customers	-	-	41,038	41,722	39,463	38,631	40,239	43,613	48,913	58,100
	Use per Customer 1/	-	-	9,652	10,603	11,838	12,731	13,084	13,698	13,370	23,500
	Use per Capita 1/	280	-	359	-	-	-	-	450	-	905
	Total Use 2/	279,800	272,800	396,101	442,388	467,146	491,792	526,507	597,416	653,987	1,365,400
44-A	Population	826,729	-	931,704	-	-	-	-	1,230,803	-	1,470,000
	Number of Customers	-	-	32,524	33,960	32,312	31,106	32,495	34,534	39,451	52,500
	Use per Customer 1/	-	-	15,140	17,543	10,689	12,611	11,849	13,779	13,821	24,390
	Use per Capita 1/	197	-	529	-	-	-	-	387	-	871
	Total Use 2/	163,200	162,000	492,423	595,747	345,389	392,274	385,037	475,845	545,263	1,280,400
44-B	Population	222,288	-	257,576	-	-	-	-	310,236	-	349,770
	Number of Customers	-	-	11,961	11,824	11,507	11,143	11,521	10,525	10,887	15,900
	Use per Customer 1/	-	-	4,542	4,936	5,807	6,240	6,786	7,934	8,712	14,400
	Use per Capita 1/	81	-	211	-	-	-	-	269	-	655
	Total Use 2/	18,100	17,800	54,331	58,365	66,822	69,537	78,176	83,510	74,844	229,000

Sheet 2 of 2

Table No. II-7

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San Francisco Regional Office

Pacific Northwest Review Report

COMMERCIAL ENERGY REQUIREMENTS
(1930-1946 Actual; 1960 Estimated)

Area or Subarea		1930	1935	1940	1941	1942	1943	1944	1945	1946	1960
45-A	Population	135,251	-	161,799	-	-	-	-	172,686	-	249,000
	Number of Customers	-	-	6,671	6,627	6,567	6,307	6,561	7,030	8,271	10,800
	Use per Customer 1/	-	-	4,557	4,847	4,789	4,925	5,238	5,616	5,999	11,000
	Use per Capita 1/	109	-	188	-	-	-	-	228	-	477
	Total Use 2/	14,744	12,194	30,402	32,119	31,452	31,062	34,365	39,483	49,620	118,800
45-B	Population	5,920	-	5,374	-	-	-	-	4,597	-	5,370
	Number of Customers	-	-	248	188	234	226	230	183	235	260
	Use per Customer 1/	-	-	3,762	5,601	4,145	3,792	3,913	5,240	5,298	9,620
	Use per Capita 1/	-	-	174	-	-	-	-	209	-	466
	Total Use 2/	-	474	933	1,053	970	857	900	959	1,245	2,500
Subtotal	Population	2,962,215	-	3,350,748	-	-	-	-	3,940,830	-	4,820,000
	Number of Customers	-	-	124,674	124,488	119,561	116,102	119,882	125,670	139,813	187,670
	Use per Customer 1/	-	-	9,456	10,411	9,083	10,251	10,360	11,468	11,730	20,066
	Use per Capita 1/	-	-	352	-	-	-	-	366	-	781
	Total Use 2/	-	558,800	1,178,861	1,296,069	1,085,983	1,190,159	1,242,031	1,441,169	1,639,973	3,765,700
30-A	Population	84,460	-	106,273	-	-	-	-	96,526	-	110,000
	Number of Customers	-	-	4,000	-	-	-	-	2,800	3,906	5,200
	Use per Customer 1/	-	-	3,882	-	-	-	-	8,254	6,802	8,900
	Use per Capita 1/	-	-	146	-	-	-	-	239	-	421
	Total Use 2/	-	-	15,528	-	-	-	-	23,111	26,569	46,300
Total Pacific North-west Region	Population	3,046,675	-	3,457,021	-	-	-	-	4,037,356	-	4,930,000
	Number of Customers	-	-	128,674	-	-	-	-	128,470	143,719	192,870
	Use per Customer 1/	-	-	9,282	-	-	-	-	11,398	11,596	19,770
	Use per Capita 1/	-	-	344	-	-	-	-	363	-	773
	Total Use 2/	-	-	1,194,389	-	-	-	-	1,464,280	1,666,542	3,812,000

1/ Kilowatt hour.
2/ 1,000 kilowatt hours.

Estimated Future Industrial Load

As a groundwork for arriving at estimates of future industrial loads, a study was made of the past power requirements of this class. In the states of Oregon, Washington and Idaho during the period 1930 to 1940 the use by all utility-served industries, excluding aluminum, increased from 1.4 billion kilowatt hours to 1.9 billion kilowatt hours, or an increase of almost 36 percent. Between 1940 and 1944 the requirements of this class increased to 4.1 billion, an increase of 115 percent. This fell off some at the end of the war, but the 1944 wartime maximum was exceeded in 1947.

The aluminum industry started operation in the Pacific Northwest in 1940; in 1944 it required 5.2 billion kilowatt hours. With the end of the war the requirements decreased rapidly but at the present time (1948), the industry is operating at near maximum capacity.

The 1960 utility requirements for the total region, excluding aluminum, have been estimated at about 9.3 billion kilowatt hours and the aluminum industry at 11.7 billion kilowatt hours, making total industrial requirements in 1960 approximately 21 billion kilowatt hours. The bases for these estimates are discussed in the following paragraphs.

It is assumed that this country will not be engaged in a major war between now and 1960, and that national security requirements during this period will not greatly exceed their presently contemplated levels. It is further assumed that there will be no serious economic disturbance during the period in question.

The total industrial load in 1960 will be made up of the power requirements of the presently existing industries and new industries which will be brought into the area between now and 1960. In estimating the industrial loads that will be served by electric utilities of the region, the industry was divided into the following classes:

1. General Industry
2. Aluminum Industry
3. Major New Industries

1. General Industry: The power requirements of this classification include those of plants, both large and small, which are presently in operation in the region, exclusive of the aluminum industry and increases due to normal industrial development and expansion. In this group are the following industries: Lumber, mining, chemical, steel, cement and many others. The future requirements of these industries were estimated on the basis of past trends and the consideration of factors such as low-cost power, growing population, availability of natural resources, etc. The utility loads of this class are estimated to increase from 3.5 billion kilowatt hours in 1946 to slightly over 7.9 billion kilowatt hours in 1960.

2. Aluminum Industry: In 1948 almost half of the nation's operating primary aluminum reduction capacity was in the Pacific Northwest. The specific location and capacity of each Northwest reduction unit is shown on Chart No. II-2. Since by far the greater part of the region's production of the metal enters the national market, the degree and rate of growth anticipated for that market will, in part, determine the extent of growth of the Northwest's aluminum operations.

It is believed that the potential aluminum market will depend primarily on the following two considerations:

First, the normal development of new uses for aluminum-- a comparatively new material with many distinctive properties and characteristics--and a more intensive use of the metal in certain proven fields.

Second, the anticipated expansion of our national security program which will place increasing demands on the aluminum industry in the immediate future.

During the past few years aluminum has displaced several other materials to a significant extent--particularly in the building materials, construction and electrical goods industries. It will be difficult to know the exact extent to which the displacement of steel in the building materials and construction fields is permanent until the present steel shortage is alleviated. Nevertheless, on the basis of views expressed by spokesmen of various related industries, it appears safe to assume that this trend will continue but at a diminishing rate as the steel supply becomes more balanced and as new competitive materials are placed on the market. On the other hand, a partial displacement of copper in the production of wire and cable will probably continue throughout the next decade.

The suitability and in some cases superiority of aluminum for numerous and diverse uses has been demonstrated on both a commercial and experimental basis. It is believed that many of those applications still in the experimental stage will be feasible of commercial development during the next decade.

In addition to what might be termed a normally increasing demand for this comparatively new metal are the rapidly mounting aluminum requirements of our expanding military establishment. The necessity for making armaments light to the point where they can be readily airborne is resulting in a proportionate increase in the use of the "light metals" for their construction.

In 1947 the Secretary of the Interior estimated 1/ that by 1952 the total production and apparent consumption of primary aluminum in the

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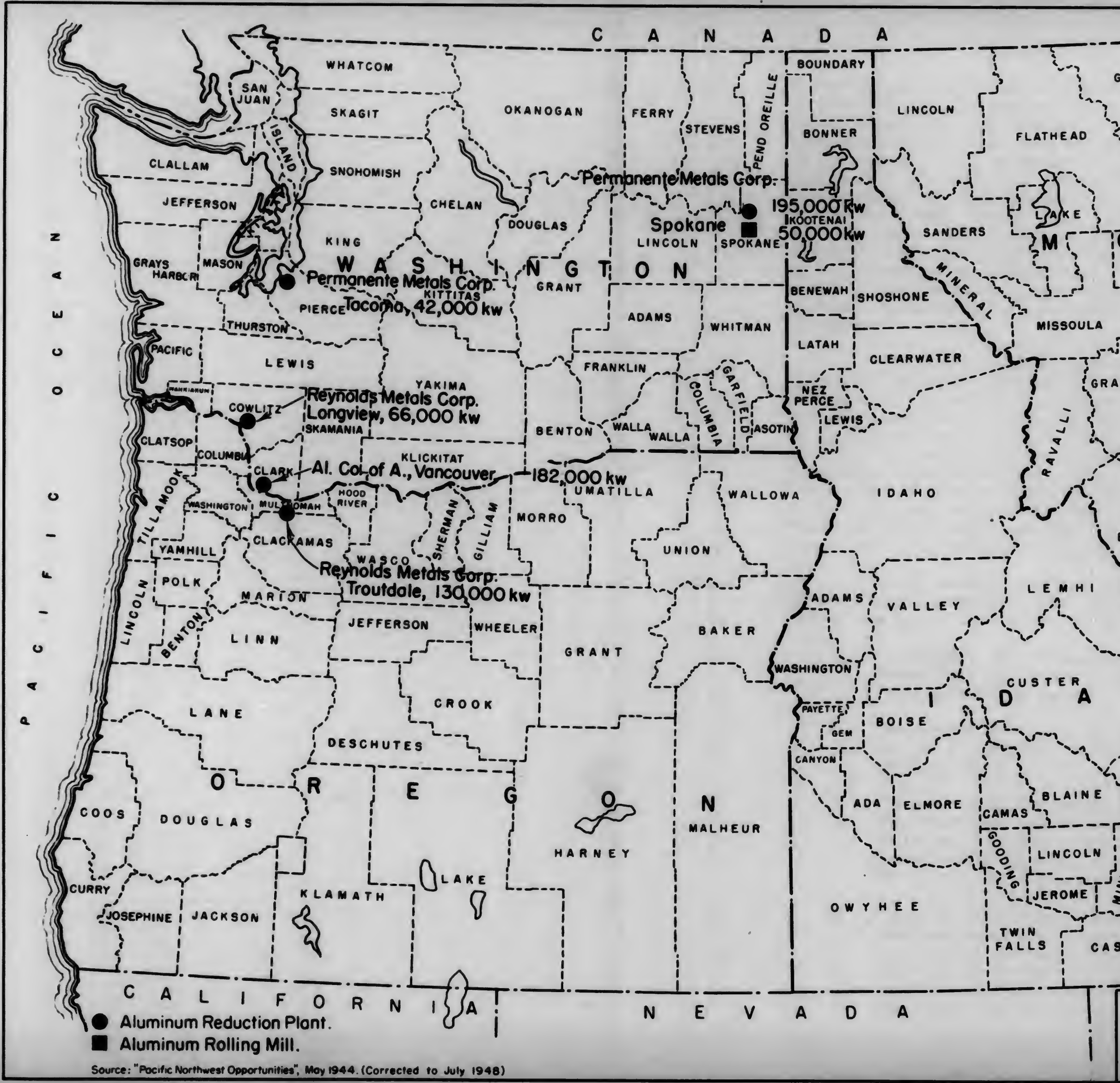
1/ "National Resources and Foreign Aid", Report of J. A. Krug, Secretary of Interior, October 9, 1947, Pg. 61.



● Aluminum Reduction Plant.
■ Aluminum Rolling Mill.

Source: "Pacific Northwest Opportunities", May 1944. (Corrected to July 1948)

FEDERAL POWER COMMISSION
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PACIFIC NORTHWEST
POWER MARKET SURVEY REVIEW

ALUMINUM PLANTS

United States would reach 600 thousand tons; by contrast in the early part of 1948, informal industry estimates which contemplate increased military demand placed 1952 requirements in excess of 1 million tons. It is true that the Secretary's estimate was made at a time when the probable impact of the nation's security program on the aluminum industry was not fully apparent; on the other hand, there is some reason to believe that the industry has been over-optimistic in estimating the rate of expansion of its future market, for it is quite probable that if military requirements increase considerably beyond their present level, concurrent political and economic considerations will necessitate the imposition of measures to curtail civilian uses of the metal. Present indications seem to point to a 1952 production level somewhere between the national requirements estimated by the Secretary of the Interior and the aluminum industry's estimates.

The present operable national capacity is inadequate to meet the increasing demands; consequently, if the aluminum industry is to take advantage of its present and prospective markets, it must expand reduction capacity considerably. Moreover, this increase in reduction capacity must be accomplished rapidly to prevent the loss, by default, of part of the potential market to producers of competitive materials. It is not believed possible to provide sufficient hydro power in the next few years to permit the nation's aluminum industry to expand with the indicated speed; however, it is felt that a considerable expansion of aluminum reduction capacity can be accomplished in the immediate future through the construction of relatively low-cost fuel-electric plants.

It is believed that the rate at which the nation's aluminum industry expands between now and 1960 will reach its peak in the first half of the period for the following reasons:

1. The present wave of industrial expansion, which is opening many new markets for aluminum, will probably have subsided within the first part of the period.

2. The current steel shortage, which is unquestionably stimulating the use of aluminum, should be less acute in the course of the next few years.

3. The improvement of ferrous alloys and synthetic products now on the market, as well as the anticipated development of new materials and a variety of synthesized agricultural derivatives, will probably make appreciable and successively deeper inroads into that market which is feasible to aluminum.

4. Aluminum, being a comparatively new material, is still being used experimentally in many applications for which other materials may be more appropriate. As the properties and characteristics of the metal become more generally known in comparison with competitive materials, its fields of application will become more sharply defined.

In consideration of the foregoing, it is estimated that the total primary aluminum requirements of the United States will reach approximately 980 thousand tons by 1955 and 1,200 thousand tons by 1960.

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The extent to which the Northwest will share in the contemplated national market will be determined largely by the availability of low-cost power in that region. The three producers have indicated a preference for locating 50 to 75 percent of all new reduction capacity in the Northwest if sufficient power at low enough rates can be provided.

The possibilities of this industry's obtaining appreciable amounts of additional power in the Northwest within the next few years are not encouraging, even if cost were not a factor. The region is presently facing a severe power shortage which cannot be alleviated until after 1954 even if tentative construction schedules are met. It therefore appears that any major expansion of the aluminum industry which takes place between now and 1955 will, of necessity, occur in areas other than the Pacific Northwest.

The problem of national security, quite apart from that of power supply, will probably influence the location of immediately contemplated new reduction capacity. If an ample power supply at reasonable rates can be obtained elsewhere, it is believed that the interests of national security would preclude any large-scale expansion of the Northwest's aluminum capacity because of the extent to which the industry is presently concentrated there. In view of this consideration, it is felt that even if sufficient power could be made available rapidly enough at satisfactory rates, a considerably smaller increase of the region's aluminum capacity than that desired by the industry, may be expected during the next several years.

Since a rapid and substantial increase in primary aluminum production is indicated, it will be necessary to locate a large part of the new capacity contemplated for the immediate future in regions other than the Northwest. Once located elsewhere, there are a number of factors which will render unlikely a subsequent relocation of aluminum capacity in the Northwest as larger amounts of new hydro power become available there. The probable slight difference in the cost between new hydro energy in the Northwest and thermally generated energy in the Gulf Area, for example, would not warrant the cost of dismantling and moving relatively new reduction plants; furthermore, it is quite likely that the Southern Area's slightly higher power rates would be offset by the elimination of that cross-hauling which is necessary for the Northwest's aluminum reduction operations.

The various points mentioned lead to the conclusion that despite the industry's expressed preference for the region, the Northwest's primary aluminum capacity will expand very slowly during the next six or seven years, unless it is done at the expense of other industrial growth. Between 1955 and 1960 when the power situation will probably have been eased, the reliability and low cost of the region's additional hydro

energy will be conducive to a more rapid expansion of the aluminum industry in the Northwest than in other areas of the country. Under these circumstances, the annual rate of production estimated for the Northwest by 1960 is about 630 thousand tons.

The power necessary to serve this rate of production amounts to 11,700 million kilowatt hours.

3. Major New Industries: Besides the expansion of existing industries, it is probable that the following seven commodities will be in production in the Northwest by 1960:

Artificial abrasives
Electrolytic manganese
Stainless steel
Phosphates
Phosphoric acid
Phosphate fertilizers
Cellulose acetate products

Although the chemical fertilizers industry has been operating in the region for the past several years, it is included in the new industry group because the enormously increased rate of production contemplated will make it second only to the aluminum industry among the region's heaviest potential power consumers.

An F.P.C. study of the seven industries in this group indicates that with the exception of acetate products, B.P.A.'s minimum estimates for their possible development by 1960 are reasonable. Therefore, B.P.A.'s minimum estimates for the first six industries in this group have been adopted. The pertinent factors relative to estimates for the future production of cellulose acetates products are set forth in the following paragraphs.

Cellulose Acetate Products

The recently announced intention of one producer of cellulose acetate products to operate an acetate pulp plant in Oregon is consistent with the chemical industry's policy of regionalizing its operation insofar as markets and the economics of production will permit. The competitive policies of this particular industry make it reasonable to assume that one plant in addition to the one mentioned above will be established in the Northwest by 1960. It is assumed that these plants will produce acetate pulp and possibly such finished products as cellophane and synthetic moulding compounds.

Doubtless the Western market for these finished acetate products will continue to expand; however, there is little reason to believe that its center will shift from California to the Northwest in the course of the next fifteen years. In fact, the strong likelihood of a marked expansion in the production of both synthetic acetate pulp and finished acetate products in California and possibly Nevada will limit the Northwest's potential inter-regional market for these commodities.

The industry would rely primarily on the region's stands of western hemlock, and to a lesser degree on wood-waste for the required fibrous raw material. Although the stands of hemlock are of considerable magnitude, a high proportion of them are widely dispersed among other species. It is reasonable to assume that any acetate pulp plants to be built in the region will be located near the concentrated stands. Expansion of the industry, once it is established in the Northwest, may be limited by the ability of producers to acquire logs economically from the dispersed stands of hemlock. In the matter of raw materials supply, it should be further noted that the amount of wood-waste available is steadily declining due to improved methods of various forest products industries, hence the acetate pulp industry will necessarily be chiefly dependent on the region's supply of logs.

In view of these limiting factors, it is estimated that the maximum rate at which the Northwest is likely to be producing all cellulose acetate products by 1960 is 34,000 tons per year. The total energy consumption at this rate would be about 190 million kilowatt hours annually. Since the technical processes involved in the production of acetate pulp make it economically feasible for the industry to generate approximately 80 percent of the energy used, it is anticipated that this industry will only purchase about 38 million kilowatt hours annually.

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It was noted above that B.P.A.'s minimum estimates for the regional development of all but one of the seven new industries have been adopted. Therefore, those data concerning new industries which are pertinent to this report may be tabulated as follows:

Estimated Rate of Production and Energy Consumption of Major New Industries by 1960

Industry	Tons	Millions of Kwh
Artificial abrasives	18,000	100
Electrolytic manganese	7,000	63
Stainless steel	6,000	7
Phosphates	27,100	183 1/
Phosphoric acid	400,000	11 1/
Phosphate fertilizers	234,900	917 1/
Cellulose acetate products	34,000	38 2/
Total energy consumption		1,319

1/ Idaho only - B.P.A.'s minimum estimate includes Montana (outside area studies by F.P.C.), and British Columbia production.

2/ Purchased energy only; total consumption is estimated at 189 million kilowatt hours.

In addition to the energy sold by utilities for industrial purposes, there are quite a number of plants that generate all or a large part of the energy used in their operations. These plants are principally the ones which require steam in the processing of their materials or use waste wood as a source of cheap fuel. They include sugar refineries, food processing, pulp and paper products, mining, smelting and lumber. The total generation of energy by these industries for their own use ranged from 1,055 million kilowatt hours in 1939 to a maximum, or 1,306 million kilowatt hours in 1942.

In the future some of these industries will probably discontinue the generation of electric power for their own use. As generating capacity becomes worn out or obsolete, the industry will replace part of its output by purchase of low-cost power. However, it is estimated that industry will generate approximately one billion kilowatt hours for its own use in 1960.

In summation, the known and estimated geographical distribution of the region's total energy requirements for industrial use are shown for the past and the future by power supply areas on Table No. II-8. It is evident from this table that the rates at which energy consumption is expected to increase for industrial use other than aluminum reduction are greatest in Idaho. This is due primarily to the enormous anticipated expansion of the phosphate fertilizer industries in the southern part of this state.

If the phosphate and phosphate fertilizer industries as well as the aluminum industry are eliminated from consideration, it will be evident that the rate of industrial development expected in each power market area does not change the established intraregional pattern of industrial activity.

Sheet 1 of 2

Table No. II-8

Federal Power Commission
San Francisco Regional Office

Pacific Northwest Review Report

PAST AND ESTIMATED FUTURE
INDUSTRIAL ENERGY REQUIREMENTS
ELECTRIC UTILITY SYSTEMS
(1930-1946, Actual; 1960, Estimated)

Industrial Use - 1,000 Kwh

Area or Subarea		1930	1935	1940	1941	1942	1943	1944	1945	1946	1960
30-A	Aluminum Industry	0	0	0	0	0	0	0	0	0	0
	All Other Industries	N.A.	N.A.	33,130	N.A.	N.A.	N.A.	N.A.	49,448	42,330	71,000
	Total Use	"	"	33,130	"	"	"	"	49,448	42,330	71,000
41-A	Aluminum Industry	0	0	0	0	0	0	0	0	0	0
	All Other Industries	14,982	15,114	17,100	17,577	19,591	22,211	22,536	23,463	28,844	618,350
	Total Use	14,982	15,114	17,100	17,577	19,591	22,211	22,536	23,463	28,844	618,350
41-B	Aluminum Industry	0	0	0	0	0	0	0	0	0	0
	All Other Industries	36,679	32,029	57,098	76,246	75,049	100,214	131,355	136,312	130,968	885,350
	Total Use	36,679	32,029	57,098	76,246	75,049	100,214	131,355	136,312	130,968	885,350
41-C	Aluminum Industry	0	0	0	0	0	0	0	0	0	0
	All Other Industries	6,300	7,300	13,773	14,518	12,702	7,413	8,471	8,661	12,849	24,000
	Total Use	6,300	7,300	13,773	14,518	12,702	7,413	8,471	8,661	12,849	24,000
42	Aluminum Industry	0	0	0	0	318,316	1,326,757	1,823,890	1,159,270	540,041	2,285,000
	All Other Industries	255,700	244,300	507,962	532,137	507,398	583,093	691,521	432,607	441,654	900,000
	Total Use	255,700	244,300	507,962	532,137	825,714	1,909,850	2,515,411	1,591,877	981,695	3,185,000
43	Aluminum Industry	0	0	0	0	58,616	350,410	356,980	295,250	700	2,334,000
	All Other Industries	495,200	421,900	681,692	808,012	1,075,400	1,343,908	1,483,396	1,326,906	1,199,122	3,483,000
	Total Use	495,200	421,900	681,692	808,012	1,134,016	1,694,318	1,840,376	1,622,156	1,199,822	5,817,000
44-A	Aluminum Industry	0	0	94,901	1,213,500	2,283,006	2,950,031	3,009,485	2,345,829	2,299,803	7,081,000
	All Other Industries	478,300	541,900	508,110	538,616	1,063,571	1,361,493	1,424,444	1,343,561	1,060,463	2,376,000
	Total Use	478,300	541,900	603,011	1,752,116	3,346,577	4,311,524	4,433,929	3,689,390	3,360,266	9,457,000
44-B	Aluminum Industry	0	0	0	0	0	0	0	0	0	0
	All Other Industries	62,300	65,400	54,583	61,016	63,825	82,002	237,817	506,757	460,557	700,000
	Total Use	62,300	65,400	54,583	61,016	63,825	82,002	237,817	506,757	460,557	700,000
45-A	Aluminum Industry	0	0	0	0	0	0	0	0	0	0
	All Other Industries	52,932	49,081	67,387	81,048	88,553	95,398	95,138	89,432	102,367	210,000
	Total Use	52,932	49,081	67,387	81,048	88,553	95,398	95,138	89,432	102,367	210,000
45-B		No industrial use in this area.									

Sheet 2 of 2

Table No. II-8

Federal Power Commission
San Francisco Regional Office

Pacific Northwest Review Report

PAST AND ESTIMATED FUTURE
INDUSTRIAL ENERGY REQUIREMENTS
ELECTRIC UTILITY SYSTEMS
(1930-1946, Actual; 1960, Estimated)

Industrial Use - 1,000 Kwh

Area or Subarea		1930	1935	1940	1941	1942	1943	1944	1945	1946	1960
Total											
Wash.-Ore.-Idaho											
	Aluminum Industry	0	0	94,901	1,213,500	2,659,938	4,627,198	5,190,355	3,800,349	2,840,544	11,700,000
	All Other Industries	1,402,393	1,377,024	1,907,705	2,129,170	2,906,089	3,595,732	4,094,678	3,867,699	3,436,824	9,196,700
	Total Use	1,402,393	1,377,024	2,002,606	3,342,670	5,566,027	8,222,930	9,285,033	7,668,048	6,277,368	20,896,700
Pacific North-West	Aluminum Industry			94,901					3,800,349	2,840,544	11,700,000
	All Other Industries			1,940,835					3,917,147	3,479,154	9,267,700
	Total Use			2,035,736					7,717,496	6,319,698	20,967,700

Essentially, the Northwest's industrial location pattern was set several decades ago by the concentration of population primarily in the western parts of the coastal states of Oregon and Washington. The growth of other areas within the region has been slow, depending almost entirely upon the development of mining and agriculture. Sporadic increases such as that expected in the phosphate and phosphate fertilizer industries in Idaho are the exceptions rather than the rule.

The greater part of the Northwest's primary aluminum reduction industry is presently located in Washington and Oregon near existing sources of power and near ports through which water-borne shipments of raw materials can be made. Because of the more favorable transportation costs available to tidewater plants, it is expected that the industry's future development will take place principally in those existing centers of production located in the coastal areas.

Railroads and Railways

The requirements for electrified railroads and street railways in the region amounted to 271 million kilowatt hours in 1945, an increase of 47 percent over 1940. This large increase was due principally to war conditions. In 1946 the requirements dropped to 241 million kilowatt hours.

It is probable, under normal conditions, that the future load of the presently electrified railroads and the loads of the street railway systems will not exceed the 1945 load. In addition to this, there is also a load which will result from further railroad electrification that may be expected by 1960. Early electrification is expected on 212 miles of the Chicago, Milwaukee, St. Paul and Pacific Railroad between Avery, Idaho, and Othello, Washington, and on 85 miles of the Great Northern Railway from Skykomish to Seattle, Washington. Electrification of other parts of the Great Northern is also expected and possibly some on the Northern Pacific Railroad. It is estimated that because of additional electrification, the railroad and railway load will increase to about 440 million kilowatt hours by 1960.

Irrigation Pumping

The irrigation pumping load, which was reported by utilities, amounted to 118 million kilowatt hours in 1946. There was undoubtedly additional energy used for this purpose which was reported under another classification as some utilities sell energy for irrigation pumping under a General Power Schedule and report it as part of their industrial load.

Based on the requirements of the Bureau of Reclamation projects (about 2,400 million kilowatt hours) and the requirements of individuals and small groups of farm operators, it is estimated that irrigation pumping will require 2,600 million kilowatt hours in 1960.

Other Sales

The sales classification designated as "Other" includes energy sold for street and highway lighting, other sales to public authorities for municipal purposes, sales to military establishments and miscellaneous sales not previously classified. In 1946 sales under this classification amounted to 529 million kilowatt hours of which approximately 5.4 percent was used for street lighting, 6.9 percent for military establishments and the remainder for municipal and miscellaneous purposes.

Estimates of future loads in these classifications have been made on the basis of population increase. It is estimated that by 1960 these requirements will amount to 800 million kilowatt hours.

Losses, Utility Use and Energy Unaccounted For

The foregoing estimates of electric utility energy requirements for the various classifications do not include transmission and distribution losses, energy used by utilities in their operations and energy unaccounted for which must be added to the estimates of classified sales to arrive at the total load on generating plants.

The ratio of losses to sales for the Pacific Northwest region has varied from 24.2 percent in 1940 to 16.3 percent in 1945 and 19.0 percent in 1946. The greatest influence on this ratio of losses to sales is due to the industrial requirements which varied from 39.9 percent of the total sales in 1940 to 59.5 percent in 1945 and 51.4 percent in 1946.

It is estimated that losses will be 16.6 percent of the total sales in 1960, excluding requirements for the Grand Coulee irrigation pumping project. No losses are allowed for this project since the pumps are located very close to the Grand Coulee generating plant.

Summary

Table No. II-9 shows past energy requirements by use classification by subareas for the years 1940, 1945 and 1946, and the estimated requirements for 1960. It will be noted that the total energy requirements of utility systems for the year 1960 is estimated to be 43.6 billion kilowatt hours.

Sheet 1 of 6

Table No. II-9

Federal Power Commission
San Francisco Regional Office

Pacific Northwest Review Report

SUMMARY OF
ELECTRIC POWER REQUIREMENTS
(1940-1946, Actual; 1960, Estimated)

Area or Subarea	Use Classification	1940			1945			1946			1960		
		Energy 1,000 Kwh	Percent of Utility Sales	Index 1940=100	Energy 1,000 Kwh	Percent of Utility Sales	Index 1940=100	Energy 1,000 Kwh	Percent of Utility Sales	Index 1940=100	Energy 1,000 Kwh	Percent of Utility Sales	Index 1940=100
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
30-A	Rural)	32,294	23.3	100	42,765	22.5	132	50,068	28.0	155	110,100	22.9	341
	Residential)												
	Commercial	15,528	11.2		23,111	12.1	149	26,569	14.8	171	46,300	9.6	298
	Industrial	33,130	24.0		49,448	25.9	149	42,330	23.7	128	71,000	14.8	214
	Irrigation Pumping	1/			1/			1/			42,200	8.8	-
	Railroads and Railways	28,869	20.9		50,534	26.5	175	41,256	23.0	143	173,000	36.1	600
	Other	28,447	20.6		24,758	13.0	87	18,853	10.5	66	37,400	7.8	131
	Utility Sales - Subtotal	138,268	100.0		190,616	100.0	138	179,076	100.0	130	480,000	100.0	347
	Losses and Company Use	20,406	14.8		29,352	15.4	144	30,748	17.2	151	78,000	16.3	384
	Utility Systems - Subtotal	158,674		100	219,968		139	209,824		132	558,000		352
	Industrial Generation for Own Use	16,826			23,325			N.A.			32,200		
	Total Energy Requirements	175,500			243,293			209,824			590,200		
41-A	Rural)												
	Residential)	28,903	44.5	100	40,604	47.0	140	49,860	45.9	173	152,800	18.5	529
	Commercial	8,865	13.7		10,402	12.0	117	13,671	12.6	154	34,000	4.0	384
	Industrial	17,100	26.3		23,463	27.2	137	28,844	26.6	169	618,350	74.9	3,616
	Irrigation Pumping				Included with industrial			-	-	-	10,600	1.3	-
	Railroads and Railways	-	-		-	-	-	-	-	-	-	-	-
	Other	7,647	11.8		7,983	9.2	104	9,021	8.3	118	10,500	1.3	137
	Firm Sales for Resale 2/	2,416	3.7		3,996	4.6	165	7,108	6.6	294	2/	-	-
	Utility Sales - Subtotal	64,931	100.0		86,448	100.0	133	108,504	100.0	167	826,250	100.0	1,273
	Losses and Company Use	12,200	18.8		15,039	17.4	123	23,111	21.3	189	93,750	11.3	768
	Utility Systems - Subtotal	77,131		100	101,487		132	131,615		170	920,000		1,193
	Industrial Generation for Own Use	1,200			723			N.A.			1,000		
	Total Energy Requirements	78,331			102,210			131,615			921,000		

Footnotes on Sheet 6.

Sheet 2 of 6

Table No. II-9

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Pacific Northwest Review Report

SUMMARY OF
ELECTRIC POWER REQUIREMENTS
(1940-1946, Actual; 1960, Estimated)

Area or Subarea	Use Classification	1940			1945			1946			1960		
		Energy 1,000 kwh	Percent of Utility Sales	Index 1940=100	Energy 1,000 kwh	Percent of Utility Sales	Index 1940=100	Energy 1,000 kwh	Percent of Utility Sales	Index 1940=100	Energy 1,000 kwh	Percent of Utility Sales	Index 1940=100
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
41-B	Rural)	114,906	34.0	100	190,342	37.3	166	231,194	40.2	201	576,000	28.9	501
	Residential)												
	Commercial	65,639	19.4		75,048	14.7	114	93,150	16.2	142	200,300	10.0	305
	Industrial	57,098	16.9		136,312	26.7	239	130,968	22.8	229	885,350	44.5	1,551
	Irrigation Pumping	85,876	25.4		84,294	16.5	98	93,052	16.2	108	319,400	16.0	372
	Railroads and Railways	-	-		-	-	-	-	-	-	-	-	-
	Other	5,019	1.5		8,678	1.7	173	8,372	1.5	167	12,000	0.6	239
	Firm Sales for Resale 2/	9,286	2.8		15,447	3.1	166	18,135	3.1	195	2/	-	-
	Utility Sales - Subtotal	337,824	100.0		510,121	100.0	151	574,871	100.0	170	1,993,050	100.0	590
	Losses and Company Use	103,760	30.7		112,857	22.1	109	131,448	22.9	127	357,950	18.0	345
	Utility System - Subtotal	441,584		100	622,978		141	706,319		160	2,351,000		532
	Industrial Generation for Own Use	24,867			18,575			N.A.			20,000		
	Total Energy Requirements	466,451			641,553			706,319			2,371,000		
41-C	Rural)	9,233	31.1	100	15,269	45.8	165	19,047	44.5	206	56,400	54.7	611
	Residential)												
	Commercial	5,961	20.0		8,427	25.3	141	9,982	23.3	167	18,800	18.2	315
	Industrial	13,773	46.3		8,661	26.0	63	12,849	30.0	93	24,000	23.3	174
	Irrigation Pumping	-	-	-	-	-	-	-	-	-	3,000	2.9	-
	Railroads and Railways	-	-		-	-	-	-	-	-	-	-	-
	Other	799	2.6		973	2.9	122	926	2.2	116	1,000	0.9	125
	Firm Sales for Resale 2/	5	-		1	-	20	5	-	100	2/	-	-
	Utility Sales - Subtotal	29,771	100.0		33,331	100.0	112	42,809	100.0	144	103,200	100.0	347
	Losses and Company Use	6,233	20.9		6,649	19.9	107	9,777	22.8	157	23,800	23.1	382
	Utility Systems - Subtotal	36,004		100	39,980		111	52,586		146	127,000		353
	Industrial Generation for Own Use	1,500			1,500			N.A.			1,300		
	Total Energy Requirements	37,504			41,480			52,586			128,300		

Footnotes on Sheet 6.

Sheet 3 of 6

Table No. II-9

Federal Power Commission
San Francisco Regional Office

Pacific Northwest Review Report

SUMMARY OF
ELECTRIC POWER REQUIREMENTS
(1940-1946, Actual; 1960, Estimated)

Area or Subarea	Use Classification	1940			1945			1946			1960		
		Energy 1,000 kwh	Percent of Utility Sales	Index 1940=100	Energy 1,000 kwh	Percent of Utility Sales	Index 1940=100	Energy 1,000 kwh	Percent of Utility Sales	Index 1940=100	Energy 1,000 kwh	Percent of Utility Sales	Index 1940=100
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
42	Rural) Residential)	159,893	18.3	100	305,940	13.7	191	378,774	22.3	237	1,363,600	18.6	853
	Commercial	124,206	14.3		150,079	6.7	121	178,902	10.5	144	516,500	7.1	416
	Aluminum Industry	-	-		1,159,270	52.0	-	540,041	31.8	-	2,285,000	31.2	-
	Other Industry	507,962	58.3		432,607	19.4	85	441,654	26.0	87	900,000	12.3	177
	Total Industrial	507,962	58.3		1,591,877	71.4	313	981,695	57.8	193	3,185,000	43.5	627
	Irrigation Pumping	1/			1/	-	-	1/	-	-	2,127,800	29.0	-
	Railroads and Railways	39,534	4.5		65,282	2.9	165	51,372	3.0	130	90,000	1.2	228
	Other	11,400	1.3		61,211	2.8	537	34,764	2.0	304	42,500	0.6	373
	Firm Sales for Resale 2/	28,831	3.3		56,980	2.5	198	74,024	4.4	257	2/	-	-
	Utility Sales - Subtotal	871,826	100.0		2,231,369	100.0	256	1,699,531	100.0	195	7,325,400	100.0	840
	Losses and Company Use	212,876	24.4		230,927	14.8	155	328,726	19.3	154	813,600 3/	15.5 3/	382 3/
	Utility Systems - Subtotal	1,084,702		100	2,562,296		236	2,028,257		187	8,139,000		750
	Industrial Generation for Own Use	31,770			45,308			N.A.			45,000		
	Total Energy Requirements	1,116,472			2,607,604			2,028,257			8,184,000		
43	Rural) Residential)	476,083	27.3	100	1,098,948	29.3	231	1,277,360	36.0	268	3,026,700	28.3	636
	Commercial	396,101	22.7		597,416	16.0	151	653,987	18.4	165	1,305,400	12.7	345
	Aluminum Industry	-			295,250	7.9	-	700	-	-	2,334,000	21.8	-
	Other Industry	681,692	39.1		1,326,906	35.4	195	1,199,122	33.8	176	3,483,000	32.5	511
	Total Industrial	681,692	39.1		1,622,156	43.3	238	1,199,822	33.8	176	5,817,000	54.3	853
	Irrigation Pumping	11,808	0.7		15,930	0.4	135	16,653	0.5	141	17,200	0.2	146
	Railroads and Railways	65,411	3.8		98,186	2.6	150	94,876	2.6	145	122,000	1.1	187
	Other	91,136	5.2		259,203	6.9	284	252,659	7.1	277	364,600	3.4	400
	Firm Sales for Resale 2/	19,792	1.2		52,898	1.5	267	56,992	1.6	288	2/	-	-
	Utility Sales - Subtotal	1,742,023	100.0		3,744,737	100.0	215	3,552,344	100.0	204	10,712,900	100.0	615
	Losses and Company Use	481,055	27.6		797,011	21.3	166	885,736	24.9	184	2,256,100	21.1	469
	Utility Systems - Subtotal	2,223,078		100	4,541,748		204	4,438,085		200	12,969,000		583
	Industrial Generation for Own Use	553,894			490,627			N.A.			450,000		
	Total Energy Requirements	2,776,972			5,032,375			4,438,085			13,419,000		

Footnotes on Sheet 6.

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Table No. II-9

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SUMMARY OF
ELECTRIC POWER REQUIREMENTS
(1940-1946, Actual; 1960, Estimated)

Area or Subarea	Use Classification	1940			1945			1946			1960		
		Energy 1,000 kwh	Percent of Utility Sales	Index 1940=100	Energy 1,000 kwh	Percent of Utility Sales	Index 1940=100	Energy 1,000 kwh	Percent of Utility Sales	Index 1940=100	Energy 1,000 kwh	Percent of Utility Sales	Index 1940=100
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
44-A	Rural) Residential)	320,503	21.0	100	683,544	13.3	213	862,832	17.1	269	2,830,200	20.3	883
	Commercial	492,423	32.2		475,845	9.2	97	545,263	10.8	111	1,280,400	9.2	260
	Aluminum Industry	94,901	6.2		2,345,829	45.7	2,472	2,299,803	45.5	2,423	7,081,000	50.8	7,461
	Other Industry	508,110	33.3		1,343,561	26.1	264	1,060,463	21.0	209	2,376,000	17.0	468
	Total Industrial	603,011	39.5		3,689,390	71.8	612	3,360,266	66.5	557	9,457,000	67.8	1,568
	Irrigation Pumping	-	-		-	-	-	-	-	-	5,000	-	-
	Railroads and Railways	48,542	3.2		55,243	1.1	114	51,362	1.0	106	55,000	0.4	113
	Other	54,338	3.6		205,584	4.0	378	191,319	3.8	352	314,300	2.3	578
	Firm Sales for Resale 2/	7,644	0.5		28,372	0.6	371	40,145	0.8	525	2/	-	-
	Utility Sales - Subtotal	1,526,461	100.0		5,137,976	100.0	337	5,051,187	100.0	331	13,941,900	100.0	913
	Losses and Company Use	271,468	17.8		615,198	12.0	227	667,537	13.2	246	1,740,100	12.5	641
	Utility Systems - Subtotal	1,797,929		100	5,753,176		320	5,718,724		318	15,682,000		872
	Industrial Generation for Own Use	369,537			347,977			N.A.			350,000		
	Total Energy Requirements	2,167,466			6,101,153			5,718,724			16,032,000		
44-B	Rural) Residential)	93,136	42.1	100	155,098	19.6	167	199,038	25.0	214	528,900	34.5	568
	Commercial	54,331	24.6		83,510	10.5	154	94,844	11.9	175	229,000	14.9	421
	Industrial	54,583	24.7		506,757	63.9	928	460,557	57.7	844	700,000	45.8	1,282
	Irrigation Pumping	8,061	3.6		7,439	0.9	92	8,006	1.0	99	58,600	3.8	727
	Railroads and Railways	1,708	0.8		1,951	0.3	114	1,911	0.2	112	2,000	0.1	117
	Other	5,947	2.7		21,397	2.7	360	10,843	1.4	182	13,500	0.9	227
	Firm Sales for Resale 2/	3,218	1.5		16,721	2.1	520	22,722	2.8	706	2/	-	-
	Utility Sales - Subtotal	220,984	100.0		792,873	100.0	359	797,921	100.0	361	1,532,000	100.0	693
	Losses and Company Use	66,601	30.1		134,769	17.0	202	159,010	19.9	239	291,000	19.0	437
	Utility Systems - Subtotal	287,585		100	927,642		323	956,931		333	1,823,000		634
	Industrial Generation for Own Use	48,735			39,501			N.A.			40,000		
	Total Energy Requirements	336,320			967,143			956,931			1,863,000		

Footnotes on Sheet 6.

Sheet 5 of 6

Table No. II-9

Federal Power Commission
San Francisco Regional Office

Pacific Northwest Review Report

SUMMARY OF
ELECTRIC POWER REQUIREMENTS
(1940-1946, Actual; 1960, Estimated)

Area or Subarea	Use Classification	1940 Energy 1,000 kwh	1940 Percent of Utility Sales	1940 Index 1940=100	1945 Energy 1,000 kwh	1945 Percent of Utility Sales	1945 Index 1940=100	1946 Energy 1,000 kwh	1946 Percent of Utility Sales	1946 Index 1940=100	1960 Energy 1,000 kwh	1960 Percent of Utility Sales	1960 Index 1940=100
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
45-A	Rural) Residential)	69,577	40.3	100	107,723	43.2	155	131,985	43.6	190	426,300	55.0	613
	Commercial	30,402	17.6		39,483	15.8	130	49,620	16.4	163	118,800	15.3	391
	Industrial	67,387	39.0		89,432	35.9	133	102,367	33.8	152	210,000	27.1	312
	Irrigation Pumping	-	-		-	-	-	-	-	-	16,200	2.1	-
	Railroads and Railways	-	-		-	-	-	-	-	-	-	-	-
	Other	2,302	1.3		2,333	0.9	101	2,426	0.8	105	3,900	0.5	169
	Firm Sales for Resale 2/	3,095	1.8		10,546	4.2	341	16,240	5.4	525	2/	-	-
	Utility Sales - Subtotal	172,763	100.0		249,517	100.0	144	302,638	100.0	175	775,200	100.0	449
	Losses and Company Use	62,173	36.0		75,107	30.1	121	97,041	32.1	156	246,500	31.8	396
	Utility Systems - Subtotal	234,936		100	324,624		138	399,679		170	1,021,700		435
	Industrial Generation for Own Use	62,082			49,411			N.A.			50,000		
	Total Energy Requirements	297,018			374,035			399,679			1,071,700		
45-B	Rural) Residential)	909	41.6	100	1,209	48.1	133	1,686	52.4	185	5,000	64.1	550
	Commercial	933	42.8		959	38.1	103	1,245	38.7	133	2,500	32.1	268
	Industrial	-			-	-	-	-	-	-	-	-	-
	Irrigation Pumping	-	-		-	-	-	-	-	-	-	-	-
	Railroads and Railways	-	-		-	-	-	-	-	-	-	-	-
	Other	341	15.6		346	13.8	101	286	8.9	84	300	3.8	88
	Firm Sales for Resale 2/	-	-		-	-	-	-	-	-	2/	-	-
	Utility Sales - Subtotal	2,183	100.0		2,514	100.0	115	3,217	100.0	147	7,800	100.0	357
	Losses and Company Use	323	14.8		428	17.0	133	697	21.5	214	1,500	19.2	464
	Utility Systems - Subtotal	2,506		100	2,942		117	3,909		156	9,300		387
	Industrial Generation for Own Use	14,935			10,268			N.A.			10,500		
	Total Energy Requirements	17,441			13,210			3,909			19,800		

Footnotes on Sheet 6.

Sheet 6 of 6

Table No. II-9

Federal Power Commission
San Francisco Regional Office

Pacific Northwest Review Report

SUMMARY OF
ELECTRIC POWER REQUIREMENTS
(1940-1946, Actual; 1960, Estimated)

Area or Subarea	Use Classification	1940 Energy 1,000 kwh	1940 Percent of Utility Sales	1940 Index 1940=100	1945 Energy 1,000 kwh	1945 Percent of Utility Sales	1945 Index 1940=100	1946 Energy 1,000 kwh	1946 Percent of Utility Sales	1946 Index 1940=100	1960 Energy 1,000 kwh	1960 Percent of Utility Sales	1960 Index 1940=100
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Pacific Northwest Region	Rural) Residential)	1,305,437	25.6	100	2,641,442	20.3	202	3,201,844	26.0	245	9,076,000	24.1	695
	Commercial	1,194,389	23.4		1,464,280	11.3	123	1,667,233	13.5	140	3,812,000	10.1	319
	Aluminum Industry	94,901	1.9		3,800,349	29.3	4,005	2,840,544	23.1	2,993	11,700,000	31.0	12,329
	Other Industry	1,940,835	38.0		3,917,147	30.2	202	3,479,154	28.3	179	9,267,700	24.6	478
	Total Industrial	2,035,736	39.9		7,717,496	59.5	379	6,319,698	51.4	310	20,967,700	55.6	10,300
	Irrigation Pumping	105,745	2.1		107,663	0.8	102	117,711	0.9	111	2,600,000	6.9	2,459
	Railroads and Railways	184,064	3.6		271,196	2.1	147	240,777	2.0	131	442,000	1.2	240
	Other	207,376	4.0		592,466	4.6	286	529,469	4.3	255	800,000	2.1	386
	Firm Sales for Resale 2/	74,287	1.4		184,961	1.4	249	235,371	1.9	317	2/	-	-
	Utility Sales - Subtotal	5,107,034	100.0		12,979,504	100.0	254	12,312,103	100.0	241	37,697,700	100.0	738
	Losses and Company Use	1,237,095	24.2		2,117,337	16.3	171	2,333,826	19.0	189	5,902,300 3/	16.6 3/	477 3/
	Utility Systems - Subtotal	6,344,129		100	15,096,841		238	14,645,929		231	43,600,000		687
	Industrial Generation for Own Use	1,125,346			1,027,215			1,169,029			1,000,000		
	Total Energy Requirements	7,469,475			16,124,056			15,814,958			44,600,000		

1/ Data not reported separately by utilities and other reporting agencies.
2/ Firm sales for resale constitute sales to small utilities of which a breakdown by customer classes is not available. 1960 estimates include these sales in the customer classes shown.
3/ No losses allowed for irrigation pumping at Grand Coulee project. (2,086 million kwh)

N.A. = not available.

Charts Nos. II-3 to II-13 show in graphical form the energy requirements in the past by areas or subareas and the estimated requirements to 1960.

Peak Demands

Table No. II-10 shows, in addition to the energy requirements, the noncoincident peak demands and load factors of each subarea or area for past years and estimates for the year 1960.

The 1960 estimated annual load factors for each subarea or area were based on a study of the trend in each area for years past, together with the expected changes in the character of the future loads.

Sheet 1 of 2

Table No. II-10

Federal Power Commission
San Francisco Regional Office

Pacific Northwest Review Report

SUMMARY OF
ENERGY REQUIREMENTS, PEAK DEMANDS AND LOAD FACTORS
Utility Systems Only
(1940-1946, Actual; 1960, Estimated)

Area or Subarea		1940	1945	1946	1960
			Energy - 1,000 Kwh; Demand - Kw		
30-A	Energy Requirements	158,674	219,968	209,824	558,000
	Noncoincident Peak Demand	40,300	54,800	53,900	148,300
	Load Factor - Percent	44.8	45.8	44.4	43.0
41-A	Energy Requirements	77,131	101,487	131,615	920,000
	Noncoincident Peak Demand	14,720	20,230	24,600	149,800
	Load Factor - Percent	59.7	57.3	61.1	70.1
41-B	Energy Requirements	441,584	622,978	706,319	2,351,000
	Noncoincident Peak Demand	91,454	131,559	148,087	452,600
	Load Factor - Percent	55.0	54.1	54.5	59.3
41-C	Energy Requirements	36,004	39,980	52,586	127,000
	Noncoincident Peak Demand	8,352	9,800	13,030	32,200
	Load Factor - Percent	49.1	46.6	40.1	45.0
42	Energy Requirements	1,084,702	2,562,296	2,028,257	8,139,000
	Noncoincident Peak Demand	197,510	469,200	495,200	992,000 1/
	Load Factor - Percent	62.5	62.3	46.8	69.7 1/
43	Energy Requirements	2,223,078	4,541,748	4,438,085	12,969,000
	Noncoincident Peak Demand	482,253	880,238	924,173	2,456,500
	Load Factor - Percent	52.5	58.9	54.8	60.3
44-A	Energy Requirements	1,797,929	5,753,176	5,718,724	15,682,000
	Noncoincident Peak Demand	433,443	971,308	1,063,942	2,755,900
	Load Factor - Percent	47.2	67.6	61.4	65.0

Footnote on Sheet 2.

Table No. II-10

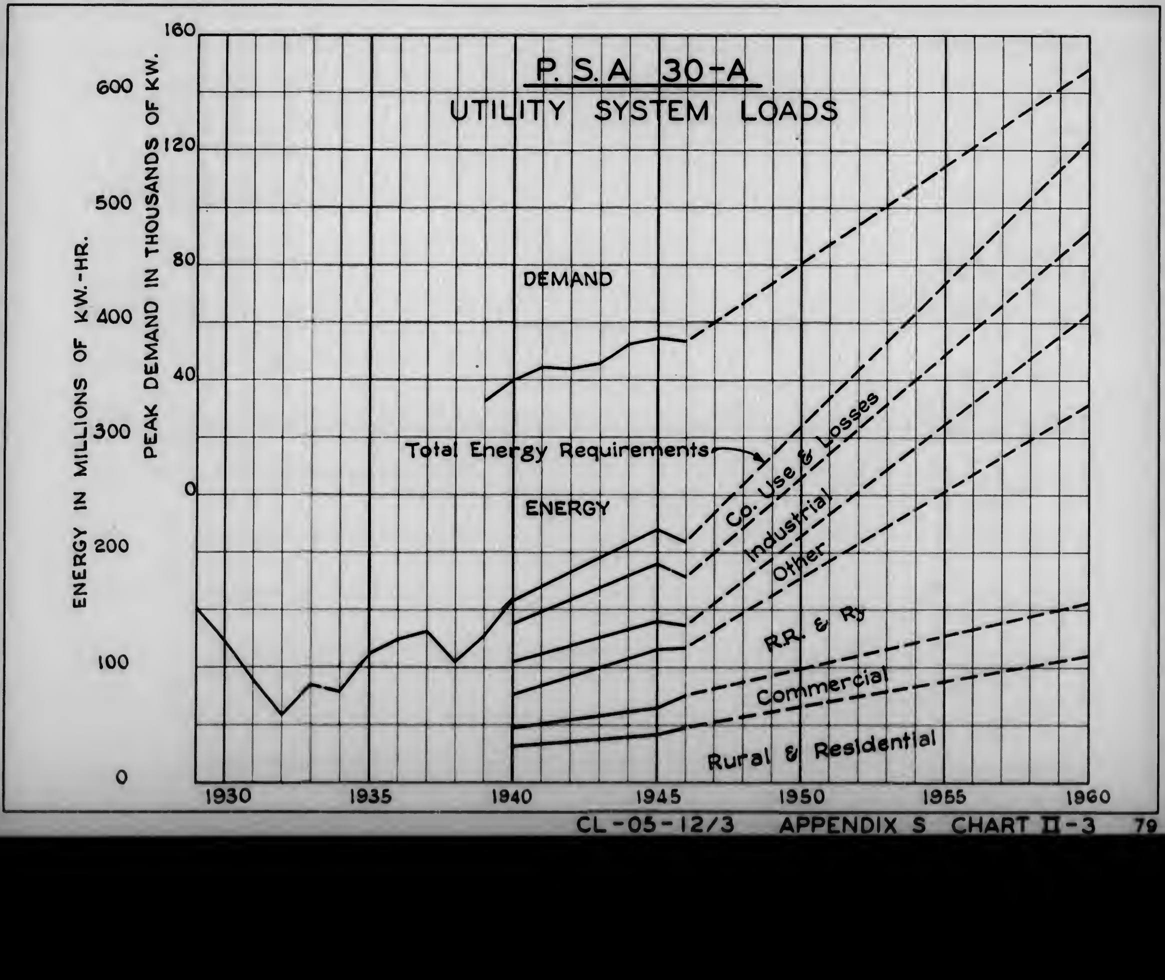
Federal Power Commission
San Francisco Regional Office

Pacific Northwest Review Report

SUMMARY OF
ENERGY REQUIREMENTS, PEAK DEMANDS AND LOAD FACTORS
Utility Systems Only
(1940-1946, Actual; 1960, Estimated)

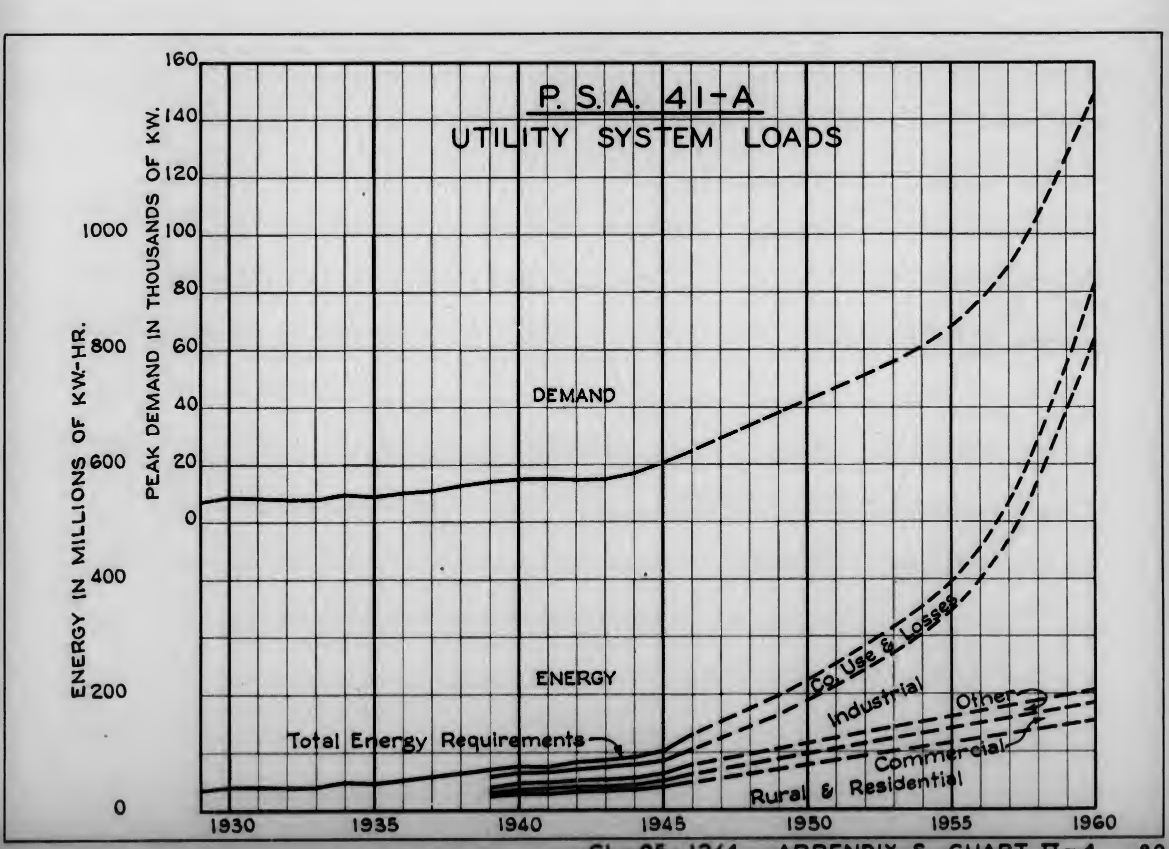
Area or Subarea		1940	1945	1946	1960
		Energy - 1,000 Kwh; Demand - Kw			
44-B	Energy Requirements	287,585	927,642	956,931	1,823,000
	Noncoincident Peak Demand	56,905	152,615	176,246	346,800
	Load Factor - Percent	57.5	69.4	62.0	60.0
45-A	Energy Requirements	234,936	324,624	399,679	1,021,700
	Noncoincident Peak Demand	48,500	68,550	87,990	212,100
	Load Factor - Percent	55.1	54.1	51.9	55.0
45-B	Energy Requirements	2,506	2,942	3,909	9,300
	Noncoincident Peak Demand	700	680	900	2,300
	Load Factor - Percent	40.8	49.4	49.6	46.2
Pacific Northwest Region	Energy Requirements	6,344,129	15,096,841	14,645,929	43,600,000
	Coincident Peak Demand	1,374,137	2,758,980	2,988,068	7,329,000 1/
	Load Factor - Percent	52.6	62.5	55.9	64.7 1/

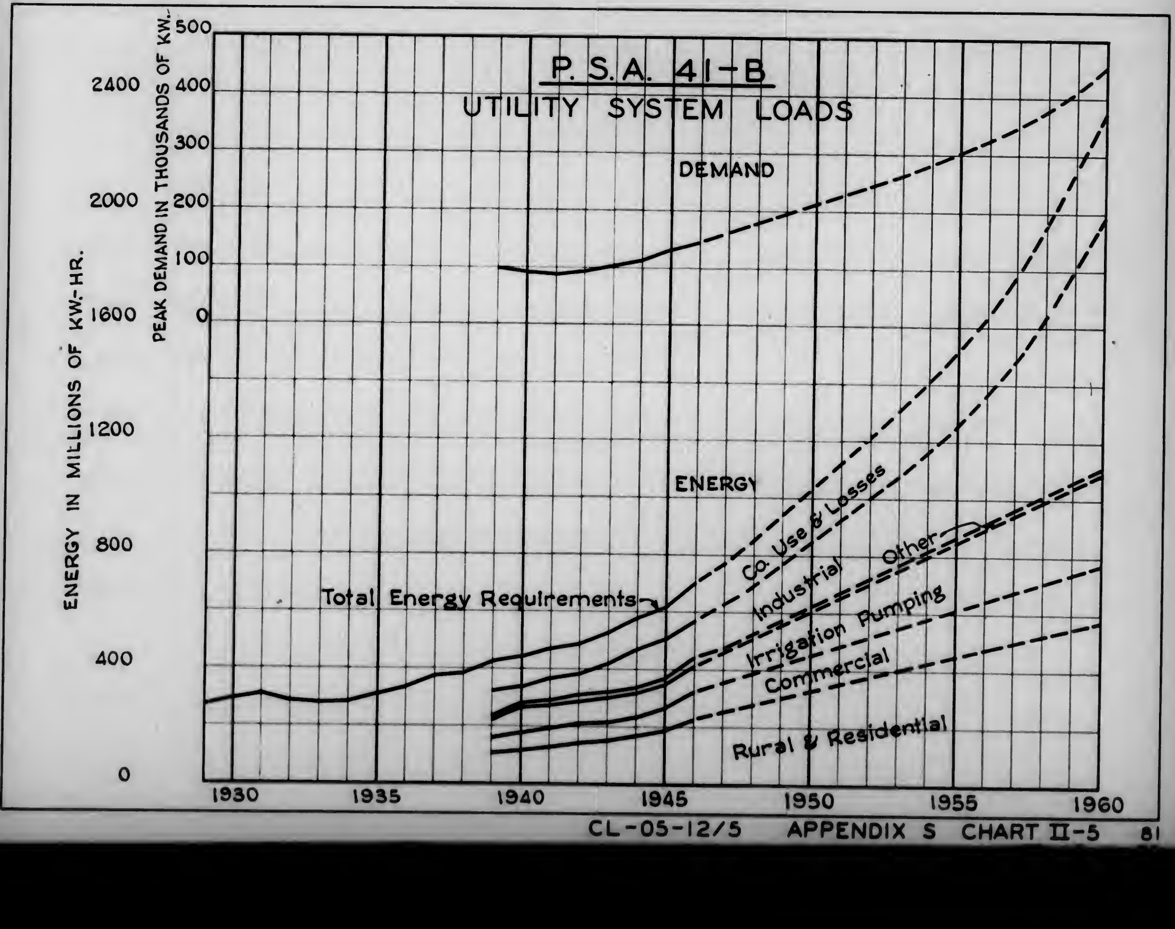
1/ December peak. Load factor based on total energy requirements minus energy required for irrigation pumping by Grand Coulee project.



CL-05-12/3 APPENDIX S CHART II-3 79

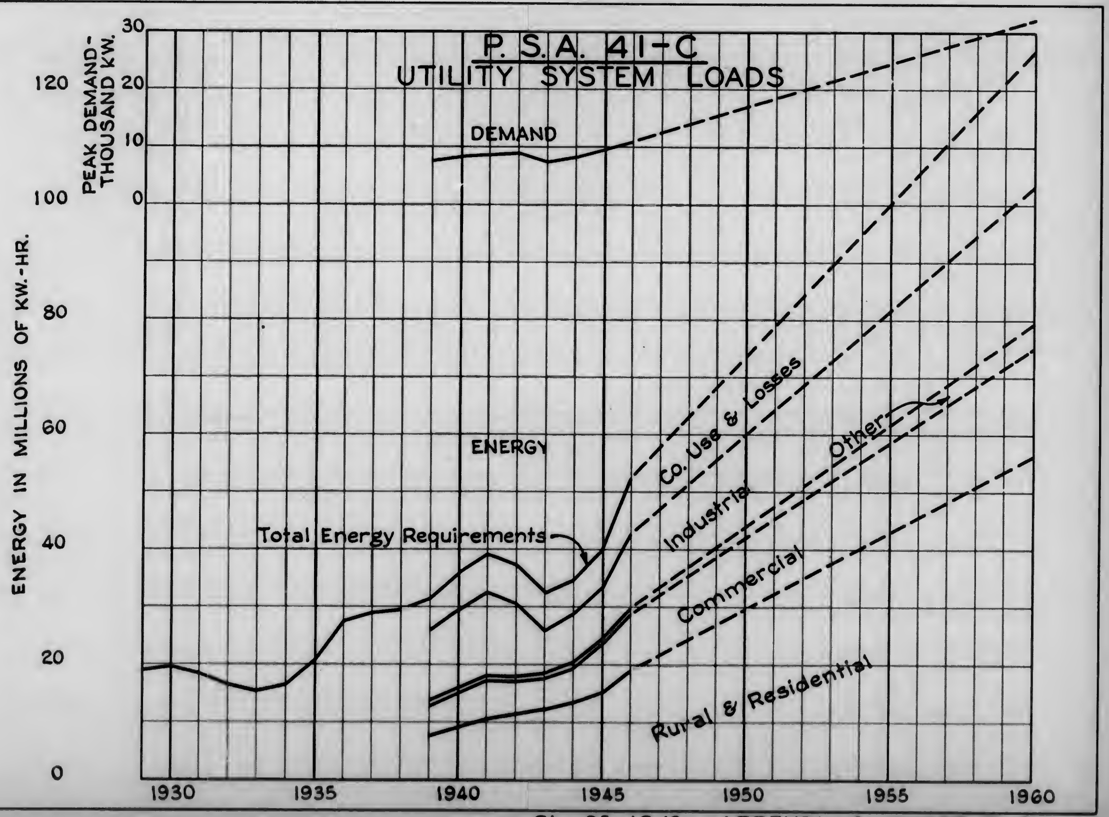
P. S. A. 41-A
UTILITY SYSTEM LOADS





P. S. A. 41-B
UTILITY SYSTEM LOADS

CL-05-12/5 APPENDIX S CHART II-5

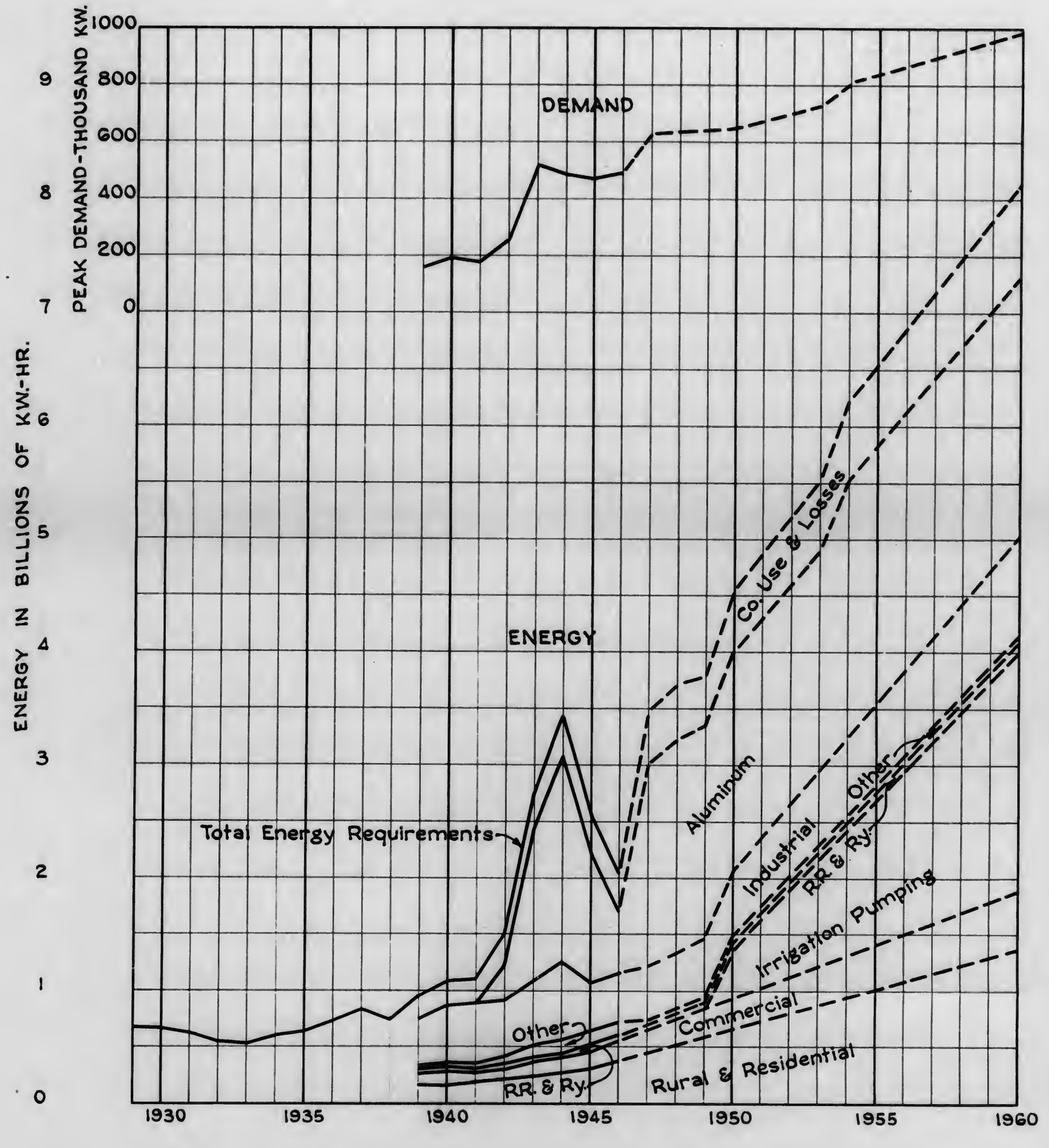


P. S. A. 41-C
UTILITY SYSTEM LOADS

CL-05-12/8 APPENDIX S CHART II-6

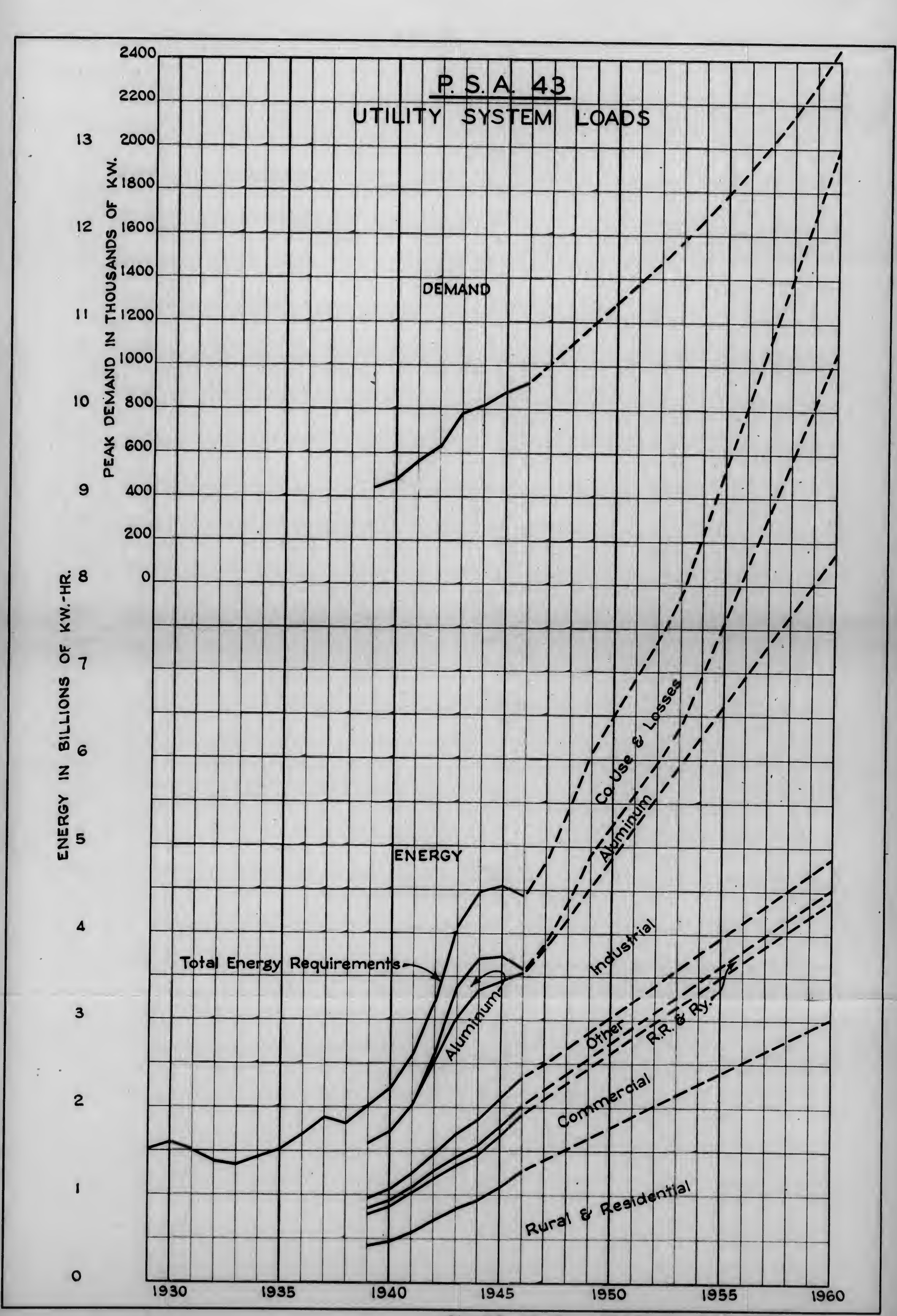
P. S. A. 42

UTILITY SYSTEM LOADS



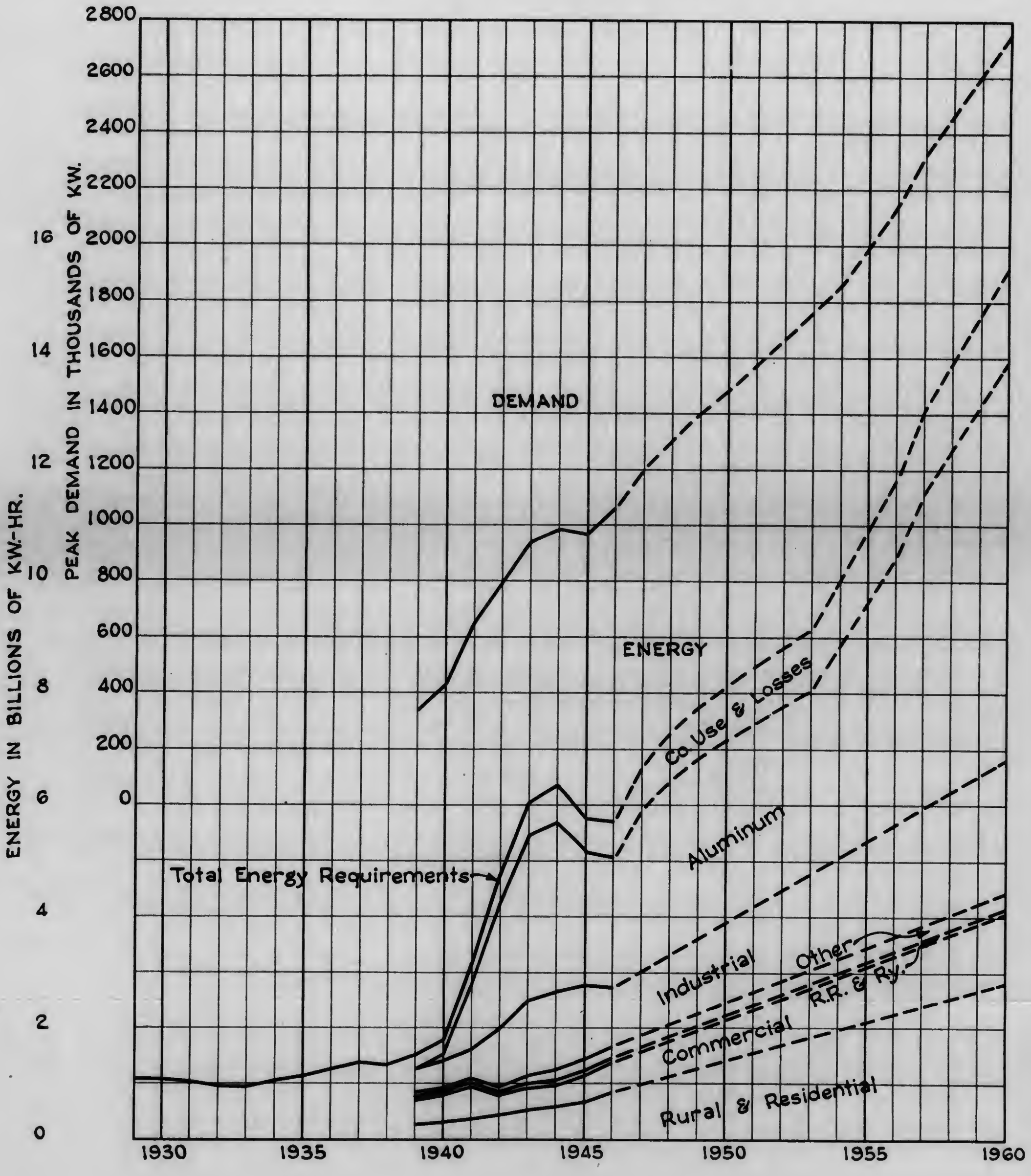
P. S. A. 43

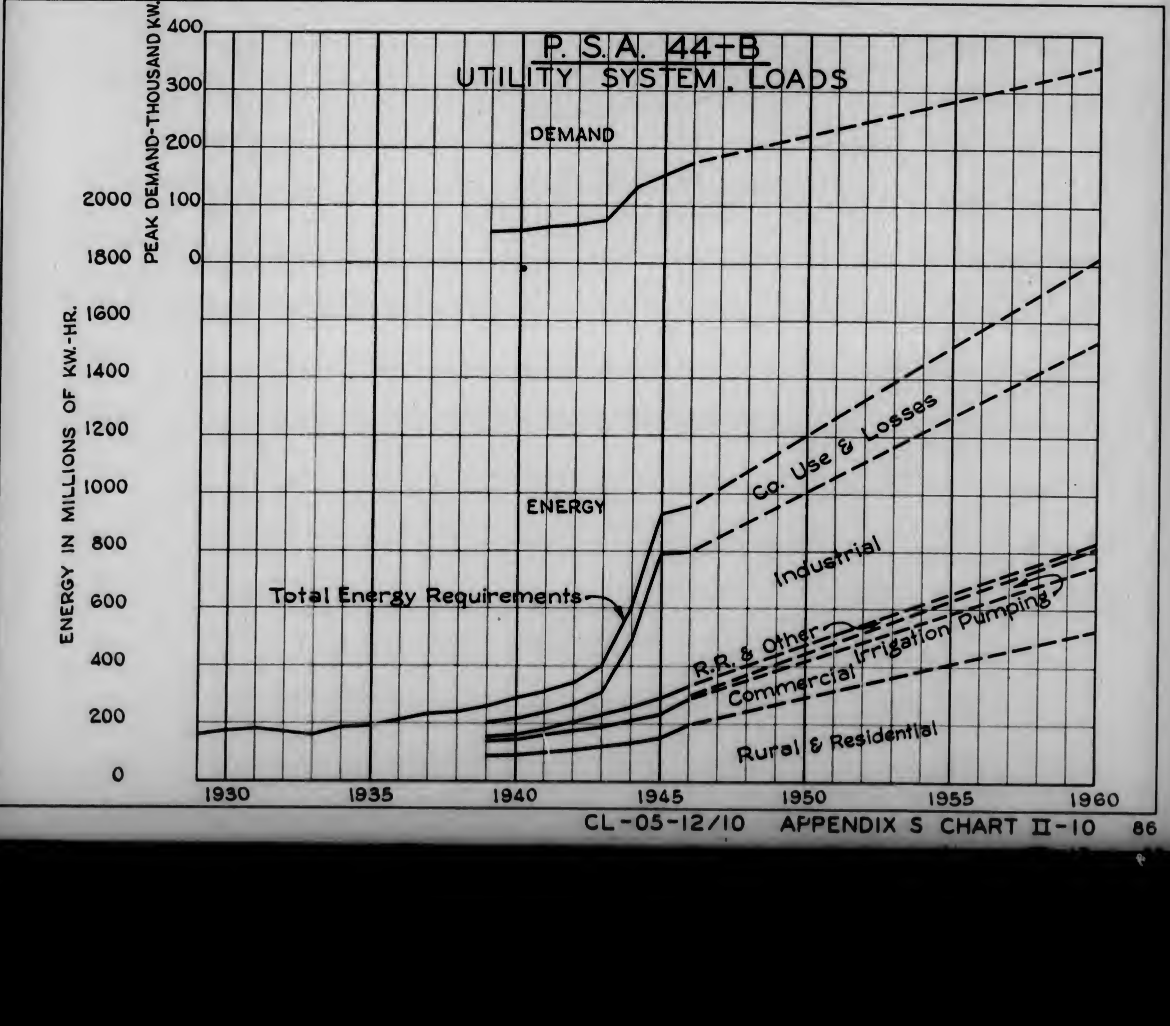
UTILITY SYSTEM LOADS



P. S. A. 44-A

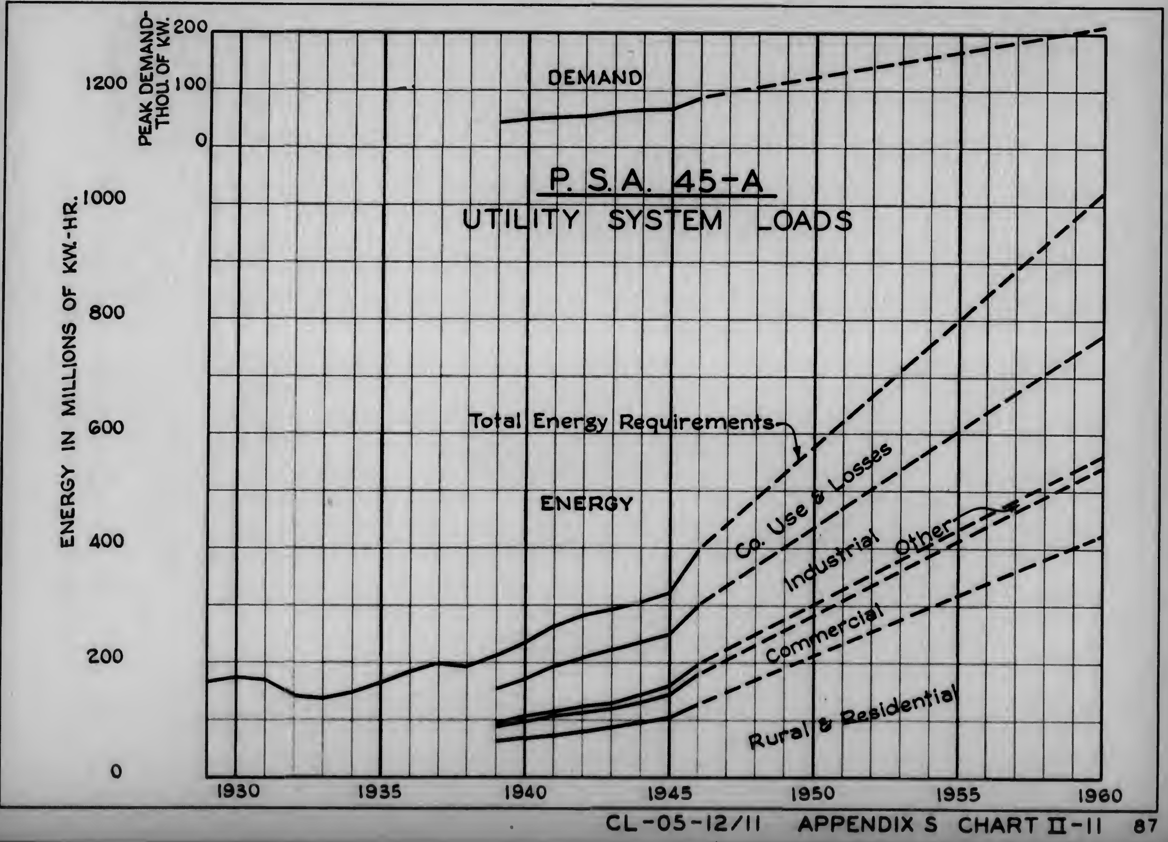
UTILITY SYSTEM LOADS

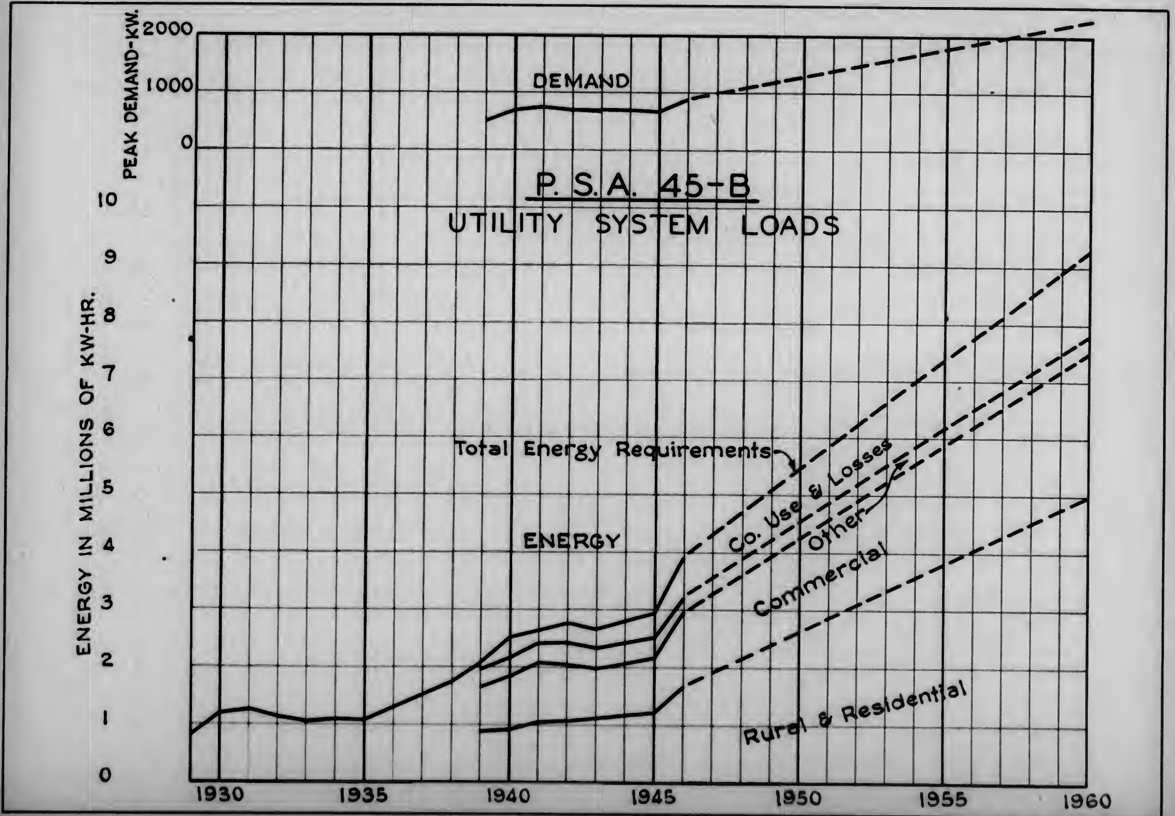




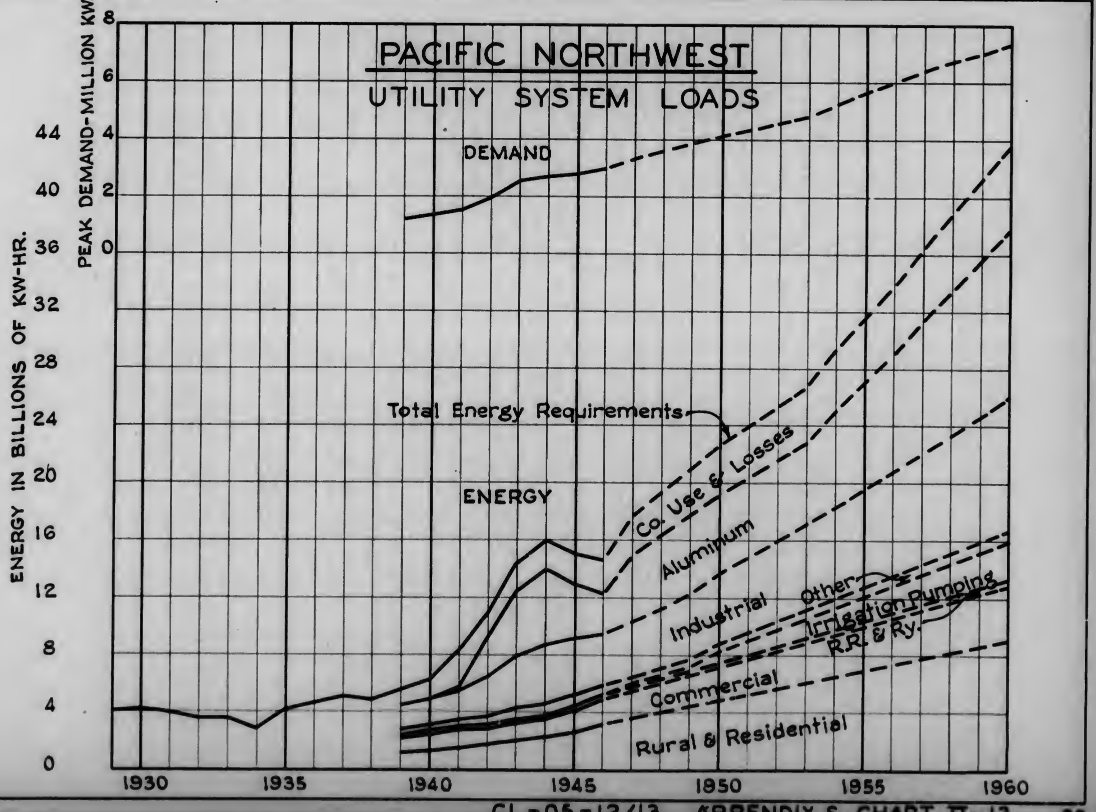
P. S. A. 44-B
UTILITY SYSTEM LOADS

CL-05-12/10 APPENDIX S CHART II-10


P. S. A. 45-A
UTILITY SYSTEM LOADS



P. S.A. 45-B
UTILITY SYSTEM LOADS



CL-05-12/13 APPENDIX S CHART II-13

PART III - COMPARISON OF B.P.A. AND F.P.C. ESTIMATES

Introduction

Part I of this study gave a brief resume' of the B.P.A. report on the future power requirements of the Pacific Northwest. Part II presented the F.P.C. study of the past and future loads of the region. In this section the load estimates of B.P.A. and F.P.C. are compared and the differences are discussed.

From the preceding Parts I and II, it will be noted that the B.P.A. estimates an increase in peak load requirements between 1946 and 1960 of 8,720,000 kilowatts while the F.P.C. expects an increase of about 4,340,000 kilowatts. This amounts to average increases per year of 623,000 kilowatts and 310,000 kilowatts, respectively.

Increases in federal and nonfederal dependable capacity (actual 1947 and planned 1948 - 1957) amount to 4,842,000 kilowatts. Assuming that the federal portion of this program is approved by The Congress; that the plants come in as scheduled; and that the average rate of increase in capacity per year is maintained until 1960, the total additional capacity then available will be about 6,800,000 kilowatts. Since reserves at the present time are practically nonexistent, the new capacity required to meet the load estimated by F.P.C. and to provide necessary reserves would be about 6,400,000 kilowatts. Therefore, it is evident that although load estimates of the F.P.C. staff are considerably less than those of B.P.A., the installation of both federal and nonfederal units must be pushed to completion as nearly as possible in accordance with the schedule in order to avoid the necessity of curtailment of load growth.

Comparison of Estimates

The following tabulation shows the comparison of the B.P.A. adopted estimate for the 1960 power requirements in the Pacific Northwest with the F.P.C. estimate developed in Part II of this study; also shown are B.P.A.'s maximum and minimum estimates:

COMPARISON OF ESTIMATED POWER REQUIREMENTS FOR PACIFIC NORTHWEST REGION - 1960

(Utility and Industrial Generation for Own Use)

(Million Kwh)

Class of Customer	BPA Estimate Maximum	 Minimum	 Adopted	FPC Estimate	
Urban Domestic	5,003	5,003	5,003		
Rural Non-farm	2,131	2,131	2,131		
Farm	1,920	1,920	1,920		
Space Heating	667	667	667		
Subtotal	9,721	9,721	9,721	9,076	
Commercial	7,200	7,200	7,200	3,812	
Industrial 1/					
Aluminum	34,000	24,000	29,300	11,700	
Small Industry	4,014	3,983	3,999		
Forest Products	3,698	2,378	3,038	10,710	2/
Other	10,774 2/	6,354 2/	10,514 2/		
Subtotal	52,486	36,715	46,851	22,410	
Irrigation	2,286	2,286	2,286	2,600	
Street Lighting	226	226	226		
Miscellaneous	800	800	800		
Subtotal	1,026	1,026	1,026	800	
Total Use	72,719	56,948	67,084	38,698	
Losses	10,181	7,973	9,392	5,902	
Total Energy Requirements	82,900	64,921	76,476	44,600	
Peak Demand(Thousands of kw)	12,698	10,325	11,840	7,329	3/
Load Factor(Percent)	74.5	71.8	73.7	64.7	3/

1/ Includes industrial generation for own use. (F.P.C. estimate one billion kwh, data not available for B.P.A. estimate.)

2/ Includes requirements for railroads and railways.

3/ Peak demand and load factor related to utility requirements, excluding irrigation pumping on Columbia River Project (2,086,000,000 kwh).

$$\frac{44600 - 2086 - 1000}{8760 \times 64.7} = 7329$$

The preceding estimates cannot be directly compared since B.P.A. includes the energy requirements for Deer Lodge and Silver Bow counties in Montana which are not included in the F.P.C. estimates. These two counties include the mining activities of the Anaconda Copper Company located in the vicinity of Butte and Anaconda. The total 1945 energy requirements in these two counties amounted to approximately 600 million kilowatt-hours, or almost 4 percent of the entire region.

The following tabulation shows comparable estimates for the states of Washington, Idaho, and Oregon:

Comparison of Estimated Power Requirements for Washington, Oregon, and Idaho - 1960

(Million Kwh)

Class of Customer	BPA Estimate Maximum	BPA Estimate Minimum	BPA Estimate Adopted	FPC Estimate
Urban Domestic	4,847	4,847	4,847	
Rural Nonfarm	2,040	2,040	2,040	
Farm	1,865	1,865	1,865	
Space Heating	637	637	637	
Subtotal	9,389	9,389	9,389	8,966
Commercial	7,082	7,082	7,082	3,766
Industrial 1/				
Aluminum	34,000	24,000	29,300	11,700
Small Industry	3,945	3,914	3,930)	
Forest Products	3,645	2,325	2,985)	10,434 2/
Other	9,810 2/	5,390 2/	9,550 2/)	
Subtotal	51,400	35,629	45,765	22,134
Irrigation	2,234	2,234	2,234	2,558
Street Lighting	219	219	219	
Miscellaneous	774	774	774	
Subtotal	993	993	993	763
Total Use	71,098	55,327	65,463	38,187
Losses	9,954	7,746	9,165	5,824
Total Energy Requirements	81,052	63,073	74,628	44,011
Peak Demand (1,000 Kw)	12,393	10,020	11,535	7,185 3/
Load Factor (Percent)	74.7	71.9	73.9	65.1 3/

1/ Includes industrial generation for own use. (F.P.C. estimate 968 million kwh, data not available for B.P.A. estimate.)

2/ Includes requirements for railroads and railways.

3/ Peak demand and load factor related to utility requirements, excluding irrigation pumping on Columbia River Project (2,086,000,000 kwh)

$$\frac{44011 - 2086 - 968}{8760 \times 65.1} = 7185$$

Discussion of Major Differences in Estimates by Customer Classifications

As indicated in the tabulation showing the comparison of the two estimates for the states of Washington, Oregon and Idaho, there are minor differences between urban domestic, rural nonfarm, farm, space heating, irrigation, street lighting and miscellaneous requirements. These differences are not great and are well within the range of accuracy obtainable. Large differences exist in the estimates of commercial and industrial loads. These are discussed in some detail in the following paragraphs.

Commercial Requirements

As will be noted from the preceding tabulation, B.P.A.'s estimate for 1960 commercial requirements is almost 90 percent higher than the F.P.C. estimate.

This difference is due in part to the different interpretations placed in this classification. B.P.A. starts with a base of 2.01 billion kilowatt hours in 1946, whereas F. P. C. uses 1.67 billion kilowatt hours. It is recognized that there is considerable room for differences of opinion in classifying sales between small industrial and commercial and that the division made is not of extreme importance as long as the same classification is maintained throughout the period under study. From the data presented in the B.P.A. report, however, it appears that part of the small industrial load used in the commercial classification may have been also used in the industrial classification. The data are so presented that definite conclusions on this point cannot be reached.

In any event, the major difference between the two estimates results from different assumptions concerning the increase in the number of commercial customers and the increased requirements per customer. For the states of Washington, Oregon and Idaho, B.P.A. has estimated that the number of customers will increase by slightly over 100 percent between 1945 and 1960, whereas F.P.C. estimates an increase of but 50 percent. The following tabulation shows the population and number of customers classified as "commercial and industrial small" by E.E.I. (B.P.A.'s source) and F.P.C. "commercial" classification for 1940 and 1945, together with estimates for 1960. The number of persons per commercial customer in each year is also shown.

Population and Commercial Customers - Washington, Oregon, and Idaho

	B.P.A.			F.P.C.		
Year	Population (Thous.)	Customers	Persons /Cust.	Population (Thous.)	Customers	Persons /Cust.
1940	3,350	128,116	26.1	3,350	124,674	26.9
1945	3,940	135,638	29.0	3,940	125,670	31.4
1960	4,820	257,640	18.7	4,820	187,670	25.7

Obviously it is not possible to state categorically that either one or the other estimate is correct. However, on the basis of past trends in both the Pacific Northwest and in other areas of the nation, the B.P.A. estimate appears high.

The B.P.A. also estimates that the use per customer will more than double between 1945 and 1960, whereas F.P.C. believes that an increase of 75 percent is more realistic. The values used by both are shown in the following tabulation:

Comparison of Actual and Estimated Use by Commercial Customers

	B.P.A.		F.P.C.	
Year	Use per Customer (Kwh)	Total Requirements (Million Kwh)	Use per Customer (Kwh)	Total Requirements (Million Kwh)
1945	13,611	1,846	11,468	1,441
1960	27,488	7,082	20,066	3,766

The large increase in use per customers estimated by B.P.A. does not appear to be consistent with the expected increase in the number of customers. If there were one commercial customer to every 18.7 persons living in the area, many of these would of necessity be small establishments using considerably less than the present average consumption.

The total commercial requirements as reported to F.P.C. increased by 157 percent during the period 1930 to 1945. During this same period the population increased by almost 33 percent. Between 1945 and 1960, with an estimated population increase of 22 percent, B.P.A. estimates increases in commercial requirements of 285 percent. The analysis by the F.P.C. staff indicates an increase of 160 percent.

Industrial Requirements

B.P.A. has subdivided this classification into two divisions; that is Small Industrial and Large Industrial. Small Industrial includes the Food Processing and All Other Small Industries. Large Industrial is subdivided into forest products; the requirements of existing aluminum pig metal plants, potential loads of alumina plants, and aluminum fabrication plants; potential increases in loads of aluminum pig metal plants in excess of requirements of existing plants; and the remainder of Large Industrial which includes the railroad electrification.

B.P.A.'s estimate for small industrial use is based on trends plus a detailed study of the Food Processing Industry. For Large Industry the total requirements are based on reports for 29 selected industries and railroad electrification. Included in their estimate are the energy requirements of industries which generate all or part of their own energy requirements.

The F.P.C. industrial load estimate includes increases based on the adjusted projection of past trends, plus the requirements of new industries which our studies indicate are likely to locate in the Pacific Northwest as the result of the region's natural resources, particularly the availability of low-cost power.

For the states of Washington, Oregon and Idaho it is estimated that the requirements in 1960 of industrial consumers, excluding the aluminum industry, will be approximately 10.4 billion kilowatt hours as compared with B.P.A.'s estimate of 16.5 billion. These estimates include the energy generated by industry for its own use and energy requirements for railroads and railways. B.P.A.'s estimate of aluminum requirements exceeds the F.P.C. estimate by 17.6 billion kilowatt hours, and their estimate for total industrial use is almost 24 billion kilowatt hours higher than F.P.C.'s. In view of this great difference a detailed analysis was made of B.P.A.'s heavy industrial estimates.

Heavy Industrial Loads

The industrial development in the Northwest, more than in any other part of the country, is dependent upon the utilization of low-cost hydroelectric power. Atomic energy may some day supplement the region's hydro-generation facilities, but nuclear physicists do not anticipate the development of atomic power plants cheap enough to permit production of electric energy in the near future. Therefore, for the period covered by this study, hydro-generated power will probably continue to be the Northwest's basic energy resource.

The future development of the Northwest's industrial economy will probably be deeply influenced by the fact that the region's power supply during the next few years will be inadequate to meet normal load growth and the needs of new large power-consuming industries that have indicated a desire to locate in the area. Since any curtailment of industrial growth would result in fewer employment opportunities, less commerce and trade, and a subsequent lowering of the region's living standard, it is pertinent to compare various existing and potential Northwest industries from the point of view of relative power consumption per wage earner. Such a comparison may well indicate that a too rapid expansion of heavy power-consuming industries could impair the region's economy in view of the outlook for additional power.

The following tabulation shows, for a number of existing or potential Northwest industries, the power requirements per man-hour and the average number of wage earners for the year 1939. Since then technological changes have altered these figures, but not to an extent that would change their relative positions in the table.

Kwh per Man-hour and Average Annual Number of Wage Earners Employed by Selected Industries in the United States - 1939

Industry Group	Kwh per Man-hour	Average Number of Wage Earners for the Year
Aluminum	586.35	2,617
Magnesium	454.55	100
Cement	57.62	23,801
Forest Products - Pulp and Paper Board	31.44	137,445
Rayon	13.01	48,332
Chemicals, except Rayon	5.58	364,542
Food and Kindred Products	3.68	784,787
Nonferrous Metals - Fabricated Products (Except Aluminum and Magnesium)	3.25	201,123
Electrical Machinery	2.82	256,467
Machinery, except Electrical	1.95	617,289
Stoves, Water Heaters, etc. (Nonelectric)	1.41	41,701
Printing and Publishing	1.37	324,535
Furniture and Finished Lumber Products	1.03	288,391
Leather and Leather Products	.65	327,663
Apparel and Finished Fabrics	.27	736,661
Miscellaneous Industries	.92	221,747

Source: National Resources Planning Board
Industrial Section
Tables Published January 1943

It will be noted from the preceding tabulation that aluminum, one of the region's largest industries, requires a much larger amount of power per man-hour than any other industry except magnesium.

It is evident that large-scale expansion of heavy power-consuming low-manpower industries during that period when the power supply is critically short can only be done at the expense of low power-consuming high-manpower industries. Since the region's power shortage is expected to last through 1954, new capacity, as it is constructed, should be distributed equitably between the two industry groups. If the heavy power-consuming group over-expands, the region's high standard of living will be jeopardized. The manner in which the industrial economy develops during the next few years will be felt far beyond 1955, for it is quite probable that during the next five to seven years, the post-World War II pattern of industrial expansion will have crystallized.

In the Northwest, the foregoing circumstances will probably affect the development of heavy power-consuming industries most acutely. It is recognized that many other parts of the Nation are also experiencing power shortages that will tend to limit their industrial expansion; however, it is believed that those areas which rely on fuel-electric power will be able to meet increased loads sooner than those areas, such as the Northwest, which are served almost exclusively by hydroelectric plants. Consequently, the necessity or desirability for expanding any of the industries in this group in the immediate future will probably result in their location in areas other than the Northwest.

Costs of power from fuel-electric plants constructed in areas where low-cost natural gas is available, may be competitive with costs in the Northwest, particularly when consideration is given to availability of raw materials and distance to market. The aluminum industry for example, is now planning the installation of a steam-electric plant in the Gulf Coast area of Texas.

For this reason it is probable that during the next several years many industrial developments planned for the Northwest will be located elsewhere. Should this occur, those particular developments must be regarded as lost to the region--certainly for the period covered by the market study.

In the preparation of its power market study, B.P.A. has assumed that this country would neither become a direct or indirect participant in another major war prior to 1960, nor pass through another economic depression. However, the present unsettled international situation may well shape national policies which will affect industrial planning for the next several years. Certainly, from the point of view of national security the desirability of concentrating any major industry in one area of the country is questionable.

In forecasting the possible development of existing and potential Northwest industries, the probably impact of heavy competition from other regions, which are closer to raw materials and major markets and in which many of the industries in question are firmly established, should not be underestimated. For example, it is not likely that the ferrous metals industry as a whole will enjoy great expansion in the Northwest because of the rapid growth of the industry in Utah and California; the history of the highly specialized artificial abrasives industry would suggest that a minimum of further decentralization may be expected in the near future; the somewhat specialized phosphates industry is presently established in California, much closer to the principal Western market centers; and it is anticipated by competent Utah state authorities that the phosphate fertilizers industry in that state will share, on an equal basis with the Northwest, those markets accessible to Western producers.

In reviewing the B.P.A.'s report no attempt has been made to check all of the detailed industrial estimates. It appears that, with the exception of primary aluminum, magnesium, and rayon, the minimum estimates presented are sufficiently in line with past trends and recognized possibilities for future expansion to justify their adoption. It should be observed however that there appears to be some inconsistency in the estimates of the extent to which aluminum will displace competitive metals in the future. In those instances where future displacement is based largely on existing price relationships, it cannot be assumed that present day prices are definitely indicative of future ones, for pricing policies can be radically altered by new sources of supply or technological developments, to mention only two causes. In those cases where future displacement is based largely on curtailment of imports of certain metals, the intensified development of domestic sources of these metals is a likelihood which cannot be discounted.

There are considerable differences between the B.P.A. and F.P.C. estimates for the future development of primary aluminum, primary magnesium, and rayon or cellulose acetate products. A detailed discussion of these differences follows:

Aluminum

The marked variance between the B.P.A. and F.P.C. estimates of the 1960 power requirements of the aluminum industry in the Pacific Northwest is occasioned in part by differences of opinion as to the 1960 national market and in part by different assumptions as to the percentage of the national market which could be supplied by reduction plants operating in the region. These differences in approach and the resulting estimates are discussed below.

Estimated 1960 National Market

B.P.A. estimates that the 1960 national primary aluminum market will be between 1,696,000 and 2,679,000 tons. On a minimum basis this would amount roughly to an increase of almost 175 percent over present production and nearly 350 percent on a maximum basis. On the other hand, F.P.C. estimates that by 1960 national demand for primary aluminum under normal conditions will amount to about 1,200,000 tons.

B.P.A. has made minimum and maximum estimates for the use of aluminum by a number of identified markets and a single estimate for "all other markets". The 1960 national requirements of the identified markets are estimated between 635,000 and 1,902,000 tons. The future requirements for "all other markets" are estimated to be 1,250,000 tons on both a maximum and minimum basis.

The minimum estimates of the identified markets appear to be reasonable and have been accepted by the F.P.C. staff. For reasons discussed below it is believed that these minimum figures are not likely to be exceeded and that the estimate for unidentified industries is at least 60 percent too high.

Building Materials and Construction

It is estimated by B.P.A. that these markets alone could use between 175 and 350 thousand tons of aluminum per year by 1960. These estimates in turn are based on the assumption that the 1946 rate of aluminum consumption by these markets (estimated at 175 thousand tons) will be maintained on a minimum basis or doubled on a maximum basis during the coming decade. It is doubtful that this will be the case in view of the probability of a considerable easing of the steel supply situation, and a steadily increasing use of synthesized agricultural derivatives.

It should also be noted that the extensive use of aluminum in residential construction has encountered considerable deep-seated consumer resistance; in industrial installations, aluminum roofing and siding is being used primarily as a substitute for steel. As familiar construction materials become more readily available and as new ones are placed on the market, it is likely that some of the present uses of aluminum will diminish rather than increase.

Transportation Equipment

The future use of aluminum by the automobile industry has been estimated by B.P.A. at 143 to 690 thousand tons per year. At least one of the economic bases for these estimates is questionable. It cannot be definitely assumed that during the next decade the cost per part made of aluminum will be less than if the same part were made of copper, zinc or some other metal. The use of aluminum for automobile bodies is not favored by the industry; wherever this application of aluminum has been made, it has usually reflected a steel shortage and been considered a substitute for that metal. It is possible that flexible synthetic plastic moldings will be used in automobile bodies. In consequence of the probable use of competitive materials, and a relaxation of the present tight steel situation, the use in 1960 by the automobile industry of more than 143 thousand tons of aluminum is questionable.

By 1960 B.P.A. estimates that the manufacture of trucks and trailers will consume 105 to 484 thousand tons of aluminum annually and that the fabrication of railroad rolling stock will use 25 to 44 thousand tons per year. In certain phases of trucking and railroading, rather costly aluminum alloys would have to be used to approach the ability of steel to withstand shock loads. On an economic basis in such instances the use of aluminum rather than steel is difficult to justify. The probability that magnesium alloys will compete heavily with aluminum in the transportation equipment industries when the use of either metal is feasible should also be borne in mind. In consideration of the foregoing, as well as the railroads' deep-rooted preference for steel, B.P.A.'s minimum estimated use of aluminum by these two industries is believed to be optimistic.

Displacement of Copper by Aluminum

Following a trend which has already become quite apparent, it is believed by B.P.A. that displacement of copper by aluminum will continue at a greatly accelerated rate. B.P.A. estimates that this market will require from 125,000 to 225,000 tons of aluminum by 1960. Although a considerable substitution of aluminum for copper may be anticipated in the future, the degree of displacement should not, it is felt, be based chiefly on the basis of the present price relationships between the two metals. In their discussion of this matter B.P.A. recognizes that as competition becomes more acute the copper industry is quite likely to make its pricing policies competitive. It is doubtful that injurious displacement will get under way before remedial action is taken by the copper industry.

Miscellaneous Uses for Aluminum

The quantitative importance of miscellaneous uses of aluminum and the difficulties in estimating the potential demands of this elusive category are acknowledged. B.P.A.'s estimate of the 1960 requirements of miscellaneous markets amounts to 66 percent of their total minimum estimate for all feasible markets. In 1939 and 1946, miscellaneous markets consumed approximately 55 and 59 percent, respectively, of all aluminum used in this country. Although new uses will continue to be found for the metal, it is probable that the miscellaneous industries market will represent a lower proportion of total markets in 1960 than in 1946 for the following reasons:

1. Historically, new materials are subjected to extensive misapplication for some time after they are first placed on the open market. There is ample reason to believe that aluminum is no exception in this respect. The 1930 decade and the war years may be regarded as a period of trail and error, during which aluminum was used experimentally in the manufacture of a very wide variety of products. Even prior to the war many of these uses were discontinued as being commercially unacceptable; subsequent to the war, notwithstanding the shortage of competing metals, more of these uses have proven technically or commercially unfeasible. As the general materials picture becomes more balanced, the particular portion of this market which is not dependent on aluminum for technical reasons, will become increasingly competitive. Experimentation in the use of aluminum will undoubtedly continue as long as the metal is produced and improved; however now that its basic properties and characteristics have become more generally known, the most appropriate fields of application will become more sharply defined. Therefore it is believed that by 1960 the requirements of the identified industries will have expanded more rapidly than those of the miscellaneous, unidentified industries.
2. In 1946 an indeterminate but large quantity of aluminum was being used as a substitute for other materials for various reasons. Such markets cannot be regarded in their entirety as permanent ones.
3. There is a strong possibility that many new uses for various materials such as other light metals, glass, synthetic plastics, and chemically treated wood will compete successfully with aluminum for new markets.

The factors noted above suggest that the miscellaneous uses market in 1960 is more likely to be below than above the 1946 percentage. Assuming 55 percent, "all other uses" would then represent a potential market of about 775 thousand tons of aluminum.

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The following tabulation presents a comparison of the B.P.A. and F.P.C. 1960 estimates of national markets for aluminum:

1960 Estimated Aluminum Requirements
(Thousands of Tons)

	B.P.A.		
	Maximum	Minimum	F.P.C.
Identified Markets	1,902	635	635
All Other Markets	1,250	1,250	775
Total	3,152	1,885	1,410
Less Secondary Aluminum	473	189	189
Total Primary Aluminum	2,679	1,696	1,221

Estimated 1960 Northwest Production

Of all the major metals in extensive use today, aluminum is the most dependent upon large blocks of electric energy for its production. Because an abundant supply of low-cost power was made available by the completion of the Bonneville system at the time when the national demand for aluminum was increasing rapidly, it is not surprising to find that the Northwest, notwithstanding its great distance from sources of raw materials and markets, was selected as the location for much of the industry's added capacity. As a result of several circumstances, today this region has approximately 50 percent of the total United States primary aluminum reduction capacity. In round figures this represents a reduction capacity of slightly more than 300 thousand tons per year in the Northwest.

The future expansion of this industry in the Northwest will depend on a number of factors which are discussed in B.P.A.'s report, in Part II of this review report and in the following pages.

B.P.A. has estimated that the Northwest's feasible primary aluminum production in 1960 will be between 1,300 and 1,800 thousand tons; F.P.C. estimates that the rate of production for the same area will be between 600 and 650 thousand tons. As previously mentioned, some part of this variance is due to a difference in the two agencies' estimates as to total national requirements. B.P.A.'s estimates indicate that the additional capacity needed in the Nation by 1960 will be between 1,070 and 2,050 thousand tons of which from 73 to 94 percent would be added in the Northwest. The F.P.C. staff estimates the increase in national capacity to be approximately 600 thousand tons by 1960, with about 55 percent in the Northwest.

B.P.A's estimate of 1960 Northwest production appears to be based very largely on the premise that sufficient energy will be available in the Pacific Northwest to the industry when it is required; and at rates more favorable than could be provided by any other area of the country.

It was pointed out earlier in this report that it is unlikely that substantial amounts of power will be available for the expansion of the aluminum industry before 1955 and it is probable that the amount available between 1955 and 1960 will be insufficient to meet the industry's requirements as estimated by B.P.A. It is stated in B.P.A.'s report that unless a huge hydroelectric construction program is started in the near future for completion by 1954, "the aluminum industry could not plan sufficiently in advance all of the expansion that is possible for the Northwest." Such a construction program would probably be authorized and carried out only to meet a national emergency. Should such an emergency present itself, the advisability of further concentration of the industry in the region would be carefully considered. The long period of construction required for major hydro plants would also be an important factor.

Although power rates in the Northwest are expected to remain at relatively low levels, the present cost of producing power from gas-fired fuel plants in the Gulf Area does not differ greatly from the cost of producing power at new sites on the Columbia River. If it is assumed that new aluminum plants built in the Northwest would have to pay the cost of constructing incremental capacity on the existing system, the industry's future rate would be considerably higher than the present $17.50 per kilowatt-year. Estimates of the costs of completing the Columbia River system to the Army's "first level," an addition of about 6.4 million kilowatts of firm power, indicate that the annual costs of this increment would be approximately $26.40 per kilowatt at a load factor of 90 percent. In the Gulf States area, the estimated annual cost 1/ of power produced by a steam-electric station using the area's natural gas at 7-1/2 2/cents per million Btu, and assuming private financing, is $25.70 per kilowatt at 90 percent load factor. Further economies can be effected by eliminating conversion losses. Consequently, it is well within the range of economic feasibility for the industry to locate new production capacity in the Southern area.

Assuming that the cost of power in the Northwest and the Gulf Area will be competitive in the future, the ability of the Northwest to provide sufficient energy to meet the aluminum industry's immediately anticipated needs becomes the major factor which will determine the extent to which the region's primary aluminum capacity may be expanded by 1960.

Aside from the foregoing considerations, the opposition of Northwest business interests as a whole to the expansion of the aluminum industry at the expense of other industries is pertinent to this discussion. Nor can the possibilities of our obtaining aluminum from the expanding Canadian aluminum industry be neglected.

1/ Based on January 1948 costs.
2/ Contracts now being considered for sale of gas to California utilities show costs at Permian Field in Texas of about 6 cents per million Btu.

In consideration of the several adverse factors noted in the preceding pages, it is concluded that the growth of the Northwest's aluminum industry will be very slight until 1955. Assuming that sufficient power will be available in the region after 1955, a large part of the aluminum capacity to be built between then and 1960 may be located in the Northwest for the following principal reasons: (1) the region is an established major producing center; (2) the industry will continue to be attracted by the region's low-cost dependable hydro power when it is available.

Accordingly, it is estimated by the F.P.C. staff that by 1955 primary aluminum capacity in the Northwest will have reached slightly more than 400 thousand tons, and that by 1960 the region's production rate will be about 630 thousand tons per year. The 1960 figure is 50 percent less than B.P.A.'s minimum estimate and about 65 percent below their maximum estimate.

The energy requirements for this estimated expansion of the region's aluminum industry would be approximately 12 billion kilowatt-hours per year by 1960. This is 12 billion kilowatt-hours less than B.P.A.'s minimum 1960 estimate of 24 billion kilowatt-hours and something less than 23 billion kilowatt-hours below their maximum estimate of 34.48 billion kilowatt-hours

Primary Magnesium

Since the close of World War II the production of primary magnesium has ceased entirely in the Northwest. The region's wartime peak production was reached in 1943 with an annual rate of about 24,000 tons or 50 percent of capacity. B.P.A. estimates that by 1960, Northwest production of primary magnesium will be between 6,000 and 25,000 tons per year. This rate represents between 4 and 15 percent of the total 1960 national market which is estimated by B.P.A. at 150,000 tons annually.

Present nonmilitary demand for this material cannot be regarded as a criterion of future nonmilitary industrial requirements since many presently indicated applications of magnesium (primary and secondary) are being deferred because of intial tooling or re-tooling which would be involved. Nevertheless, considering the present and reasonably contemplated used of magnesium and the liklihood of a very rapidly increasing supply of secondary metal, the B.P.A.'s estimate of the 1960 national primary metal market seems to be disproportionate to that for other metals.

In 1945 approximately 90 percent of the country's magnesium capacity was in idle government-owned plants, many of which have since been sold and converted to other purposes. By 1946 only two privately owned plants, located in Texas and California, were in operation; they produced 12,500 tons of primary magnesium. At the end of 1947, national demand had dropped to about 6,000 tons; at the same time, privately owned capacity was 24,000 tons. It has been estimated 1/ that future demand for the primary

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1/ "Chemical and Metallurgical Engineering," May 1945 and Federal Tariff Commission, May 1946.

metal will be approximately 30,000 tons per year. In view of increasing military requirements this estimate is probably from 50 to 70 percent low.

Considering the prospect of a future market limited to 30 to 50 thousand tons annually, greater over-all operating efficiency will be achieved by concentrating production in as few plants as possible. Recently the Northwest's only primary magnesium production facility, a government-owned electrolytic plant at Spokane, was completely acquired and converted by private operators for electrochemical production. It appears quite unlikely in view of general market limitations and high production costs, that new capacity will be built in the Northwest by 1960, since existing capacity on the Pacific Coast can more than handle any reasonable estimate for Western demand for the metal.

In view of the ready availability of magnesium from Western sources, and the conversion of the Spokane plant to other uses, it is difficult to justify the operation of any Northwest facilities to produce that relatively small quantity of the material necessary to serve the region's requirements. Consequently, it is believed that B.P.A.'s minimum 1960 production estimate of 6,000 tons is not justified and the F.P.C. review report includes no definite allowance for magnesium production in its load estimates.

It is undoubtedly true that in the event of a third World War, the demand for primary magnesium would far exceed the 30 to 50 thousand tons previously estimated primarily for nonmilitary industrial consumption. Should war become imminent, it must be borne in mind that the Spokane magnesium plant, now converted mainly to electrochemical production could, and probably would, be recaptured by the government for magnesium production.

The uncertainties of this line of reasoning do not justify forecasting any definite magnesium load; however it should be noted that the present use of this plant (electrochemical) requires an energy load roughly comparable to that which would be required for the electrolytic production of magnesium in the same plant at an annual rate of 12,000 to 24,000 tons per year. Therefore, it may be considered that a small portion of the estimated general industrial energy requirements for 1960 is available should the plant be reconverted to magnesium production.

Rayon

It is assumed by B.P.A. that within a few years manufacture of rayon will have started in the Northwest. The 1960 annual rate of production forecast by B.P.A. ranges between 67,500 and 87,500 tons.

Though produced by very few manufacturers, this industry is a highly competitive one, which has always operated fairly close to major market centers. The industry is such that if one manufacturer established West Coast rayon production facilities, he would likely be followed by the majority of his competition. The existence of three or four rayon plants on the Pacific Coast to serve the Western market, would limit production at each plant to such an extent as to preclude economically feasible operation.

The recent announcement by the Du Pont Company, of their intention to operate a cellulose acetate products plant in Oregon is consistent with the chemicals industry's policy of regionalizing its operations insofar as the economics of production will permit. It is highly questionable if any of their projected plant capacity will be devoted to rayon production, but much more likely that acetate pulp and finished acetate products such as cellophane and synthetic moulding compounds will be manufactured.

Therefore, although it is felt unlikely that rayon will be manufactured in the region by 1960, an allowance for production of various other cellulose acetate products has been made in the F.P.C. review report amounting to 34,000 tons in 1960, or approximately one-half of the minimum figure for rayon production used by B.P.A. The energy requirements for this rate of production would be in the neighborhood of from 180 to 200 million kilowatt-hours per year. B.P.A.'s comparable figures are 375 million kilowatt-hours per year on a minimum basis, and 490 million killowatt-hours on a maximum basis.

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